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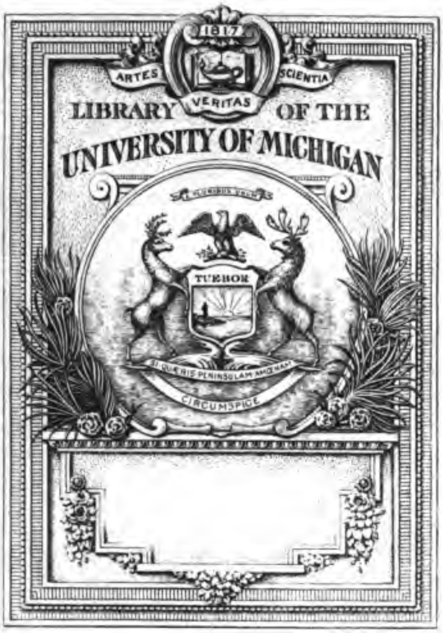

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ELEVENTH ANNUAL REPORT

OF THE

Massachusetts.

METROPOLITAN WATER AND SEWERAGE BOARD.

FOR THE YEAR 1911.

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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1911, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, it presents a detailed statement of its doings for the calendar year ending on December 31, 1911, being its

ELEVENTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

I. ORGANIZATION AND ADMINISTRATION.

(1) Board, Officers and Employés.

The term of office of Henry P. Walcott, M.D., expired on March 21, 1911, and he was reappointed for the three years next succeeding. The membership of the Board has consequently remained as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Junior. William N. Davenport has continued as secretary and in charge of the auditing department. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, two general clerks, three stenographers and clerks, a telephone operator, a messenger, and a janitor with two assistants, one of whom acts as watchman.

Such general conveyancing work and investigation of real estate titles in the different counties as has been called for during the year has been performed by George D. Bigelow and Miss Alline E. Marcy.

The consulting engineers of the Board are Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require such consideration.

Dexter Brackett, Chief Engineer of the Water Works, has had supervision over the various departments of both construction and maintenance. William E. Foss has been Assistant to the Chief Engineer and has exercised a general charge over engineering work in all departments. The following have also acted under the direction of the Chief Engineer: Elliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct and of all reservoirs and pipe lines within the Metropolitan District; and Arthur E. O'Neil, Superintendent of the several pumping stations.

There has been a slight decrease in the number of the engineering force during the past year. The average force employed on construction and maintenance during the year has included, in addition to the Chief Engineer, 4 department superintendents, 2 division engineers, 8 assistant engineers, and 35 others in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 50. The maximum engineering force employed at any one time during the year on both construction and maintenance was 57.

A maintenance force in addition to those engaged in engineering capacities, as above mentioned, numbering upon the average during the year 225, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines, and upon minor construction work. At the end of the year this force numbered 219.

William M. Brown, Chief Engineer of the Sewerage Works, has had charge of both construction and maintenance. He has been assisted during the year by Frank I. Capen and Frederick D. Smith, Division Engineers, who have been in supervision of both construction and maintenance departments of the North and South systems, by Henry T. Stiff, Division Engineer in charge of the office and drafting, by 1 assistant engineer and by 10 others employed in various engineering capacities and by two clerks and stenographers.

The maximum engineering force employed at any one time during the year on construction and maintenance of Sewerage Works was 17.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, has upon the average numbered 159.

The whole regular force of the Sewerage Department at the end of the year numbered 178, of whom the Chief Engineer and 12 assistants and draftsmen were engaged in general upon the works, and, of the remainder, 99 were employed upon the North System and 66 upon the South System.

The day-labor forces under the supervision of the engineers and the immediate direction of the foremen have been employed during the year in connection with the extension of the East Boston pumping station and its equipment, and in the building of the locker and stable buildings at East Boston.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending September 9, when the number amounted to 99.

(2) Offices and Buildings.

The offices of the Board and the secretary, and of the auditing and conveyancing departments, and the main engineering offices of both Water Works and Sewerage Works, are located in the buildings numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in Boston.

The headquarters of the Wachusett Department of the Water Works are at the gate and power house at the Wachusett Dam, in Clinton. The branch office for the Sudbury Department is maintained at South Framingham. Headquarters of the maintenance force of the Water Works for the northern part of the Metropolitan

District are maintained in the Glenwood pipe yard in Medford, where there are offices, shops, store-rooms and stables; and the maintenance force for the southern part of the District has headquarters in like buildings at the Chestnut Hill Reservoir.

Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained for the North Metropolitan System at the stable and locker building at East Boston and at the Deer Island pumping station, and for the South Metropolitan System at the Ward Street pumping station and at the storage yard at Hough's Neck.

II. METROPOLITAN WATER DISTRICT.

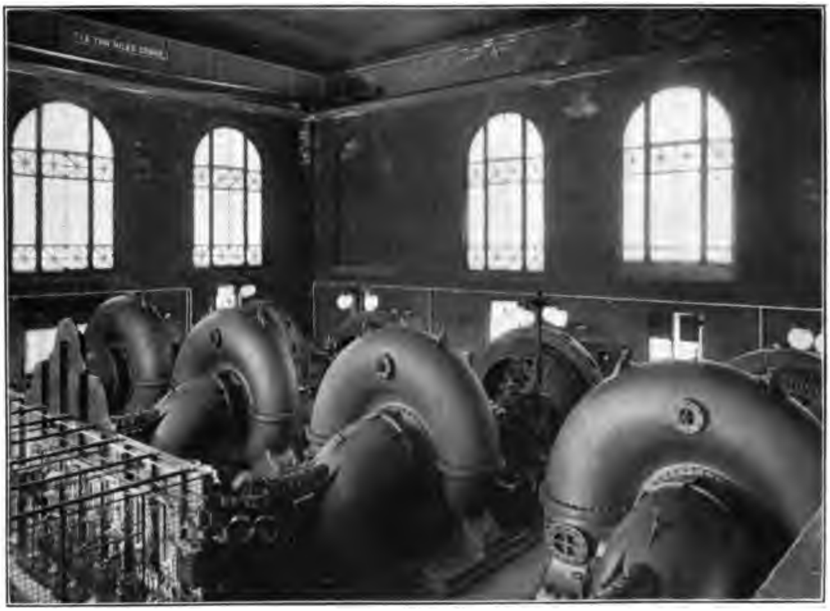
The Metropolitan Water District now comprises the cities of Boston (including by annexation the former town of Hyde Park), Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy and Somerville, and the towns of Arlington, Belmont, Lexington, Milton, Nahant, Revere, Stoneham, Swampscott, Watertown and Winthrop, — in all 9 cities and 10 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the United States Census taken for April 1, 1910, was 1,070,256. The population of the District on July 1, 1911, the date upon which calculations for the Water Works are based was estimated as 1,101,930.

The city of Newton and the town of Hyde Park, though belonging to the District, did not take water from Metropolitan sources during the year 1911, but the section formerly constituting the town of Hyde Park will be furnished with water during the year 1912.

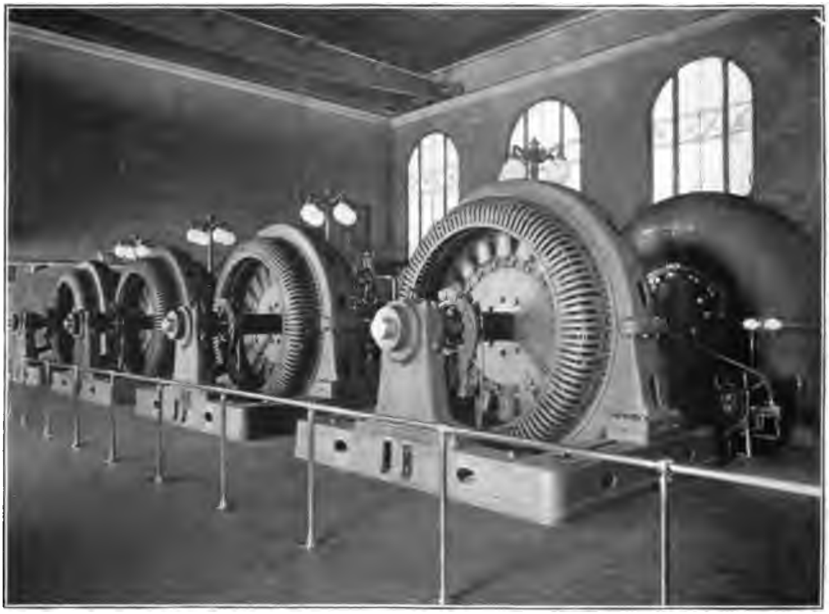
III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been $41,932,850.44.

The total amount expended during the calendar year on account of the construction and acquisition of works has been $385,920.88. There has been expended on account of the Wachusett power plant the sum of $112,564.42; for the improvement of the Wachusett watershed, the sum of $4,505.95; in the laying of the new 60-inch main for bringing the supply of water from the Weston Aqueduct



WACHUSETT POWER PLANT—View of the four Hydraulic Turbines.



WACHUSETT POWER PLANT—View of the four Electric Generators.

UNIV. OF MICH.

into the Metropolitan District, the further sum of $70,589.92; for the reinforcement of the supply of East Boston, the further sum of $19,564.92; on account of the new pumping engine which has been installed at Chestnut Hill pumping station for the use of the southern high-service district, $60,874.71; in the laying of a new main to Hyde Park and on account of the construction of a new pumping station, the sum of $107,824.97; and for other minor works, engineering and administration expenses, the remaining sum of $9,995.99.

(1) Wachusett Power Plant.

The machinery for utilizing the fall of the water at the Wachusett Dam for the development of power has been installed during the past year in the large gate and power house erected at the foot of the dam. In accordance with the contracts which had been made in the preceding year four large hydraulic turbines with four electric generators have been introduced, each turbine being guaranteed to develop 1,200 horse power with an average efficiency a little exceeding 80 per cent. The machinery is provided with an adequate equipment of valves, governors, switchboard, recording instruments and other necessary apparatus for the development and transmission of power.

The water for supplying the turbines is introduced through vertical chambers and wells originally constructed in the dam, through which it falls to a depth of about 111 feet below the line of high water in the reservoir, and is thence conveyed in pipes to the turbines from which it is afterward discharged into the Wachusett Aqueduct.

The power generated is conveyed from the power house by underground cable for a distance of 815 feet to a point near the Central Massachusetts Railroad, where a building, 20 feet long and 14 feet wide, has been erected to contain the necessary apparatus for the protection of the power house and its machinery against lightning currents, and whence the power is transmitted by an overhead pole line for about 600 feet to a connection with the line of the Connecticut River Transmission Company. At this connection the electric energy developed is delivered to the Transmission Company in accordance with a five-year contract made with the Company in the preceding year.

It is anticipated that a total, equivalent to an average of about 2,500 horse power, will be delivered to the Company, but the amount will necessarily vary according to the quantity of water required to be introduced into the Wachusett Aqueduct for the supply of the Metropolitan District, and according to the necessity of conserving the Wachusett water supply and utilizing the other sources of supply from which water is drawn for the District.

The work was completed so that the Board was able to begin to furnish power to the Connecticut River Transmission Company on August 10, 1911.

(2) Improvement of the Watersheds.

For the better protection of the waters of the Wachusett Reservoir the Board has acquired during the year several parcels of land containing in all 125.5 acres and situated in the towns of West Boylston and Sterling. The lands acquired lie on both sides of Waushacum Brook which runs from Waushacum Pond to the reservoir and is one of the principal feeders of the reservoir. They are generally of a swampy nature, in unsatisfactory condition, and would if occupied by dwellings afford a particular menace to the water supply.

Two other tracts having an area of about five acres, situated in Boylston on the margin of the Wachusett Reservoir, were acquired by exchange.

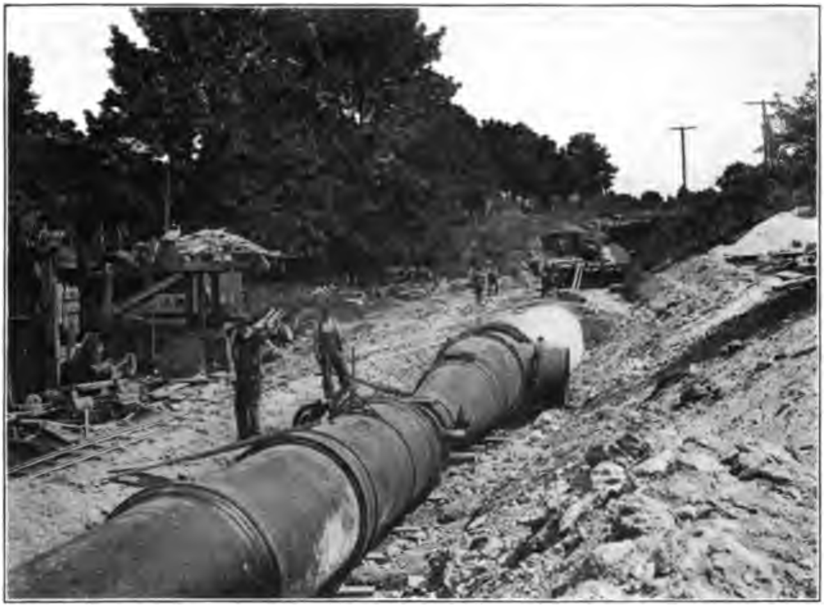
About one and a half acres in the town of Framingham were acquired for the protection of Framingham Reservoir No. 2, as their situation upon the shores of the reservoir and near the thickly settled portions of the town offered particular inducement to purchasers for building purposes.

A further small parcel in Natick of about one-fifth of an acre was acquired and added to the margin about Lake Cochituate where the shore was exposed.

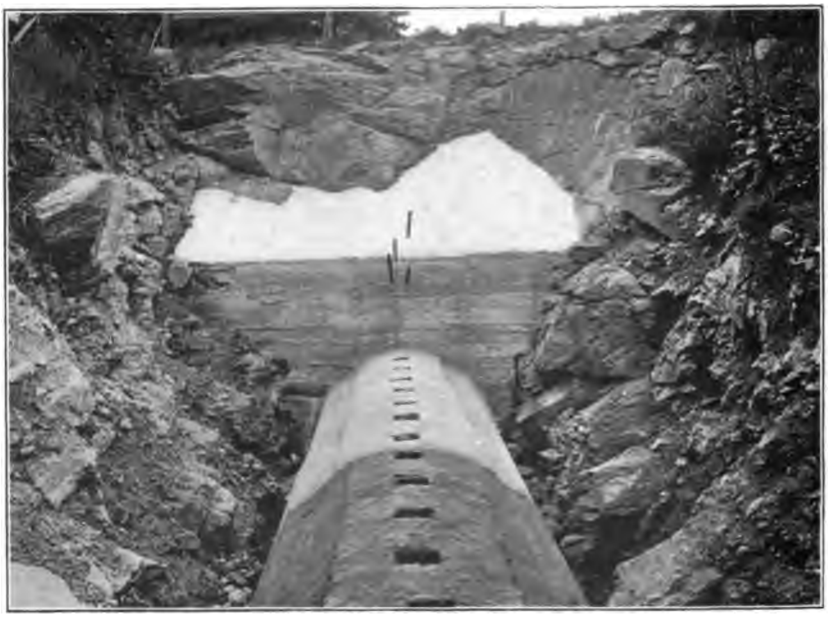
(3) Distribution System.

(a) *Additional Weston Aqueduct Supply Main.*

During the last year a section about 2,700 feet long of the additional supply main which is to connect the terminus of the Weston Aqueduct with the Chestnut Hill Reservoir, has been completed,



WESTON AQUEDUCT SUPPLY MAIN—60-inch Cast-iron Pipe connected by Valve with 80-inch Concrete-covered Steel Pipe at entrance to Newton Tunnel.



WESTON AQUEDUCT SUPPLY MAIN—Junction of 80-inch Concrete-covered Steel Pipe with 76-inch Concrete Main in Tunnel.

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so that now, of the entire length of about 34,650 feet, all the lower portion of the line for a distance of about 20,260 feet, ending with the mains near the Chestnut Hill Reservoir, has been constructed.

The most important part of the work accomplished during the past year was in connection with the tunnel which extends for a distance of a little more than 2,000 feet through a hill in the northeasterly part of the city of Newton. The rock excavation for the tunnel had been made in the preceding year, but there remained principally to be performed the concreting of the excavation for the making of the 76-inch tunnel and the making of connections at each end of the tunnel with the 60-inch iron pipes by lengths of about 180 feet of 80-inch steel pipes. The tunnel has been constructed of sufficient size to be available for another supply line in the future.

The portion of the main line completed was put into service of the water supply on November 4, 1911.

(*b*) *New Supply Main for East Boston.*

The laying of the 36-inch pipe in the tunnel under Chelsea Creek, which had been built in the previous year in order to make a further connection between East Boston and the Metropolitan Main in Chelsea, was completed, and the spaces between the pipes and the brick lining of the tunnel were filled with cement concrete. The new line was put into service on February 17, 1911, and a much-needed protection was afforded to the East Boston section in case trouble should arise with the two old mains, upon which its supply depended.

(*c*) *New Pumping Engine at Chestnut Hill.*

The new pumping engine for the southern high service has been fully installed in the Chestnut Hill pumping station and was placed in service on March 27, 1911, but the final test has not yet been made. It is capable of pumping 40,000,000 gallons per day with a lift of 130 feet.

(*d*) *Supply of Water to Hyde Park.*

Although the town of Hyde Park was included in the Metropolitan Water District it had hitherto depended upon its own sources of supply and had not been furnished with water from the Metropolitan Works. On March 28, 1911, however, it called upon the Board to furnish it with a water supply, which the town was entitled to receive upon its application under the Metropolitan Water Act. An appropriation of $212,000 for the necessary expenses of extending the system to that town was subsequently made by the Legislature and the work of construction was immediately begun.

A line of 24-inch pipe has been laid from a connection with the main line at Forest Hills in Roxbury to a point in Hyde Park near the boundary line, a distance of 10,200 feet, and from this point a further 20-inch line has been laid for a distance of 6,700 feet to make connection with the Hyde Park system in the central part of the town. Both these lines had been completed so as to be ready to furnish a supply to Hyde Park at the beginning of the year. The water which is thus supplied will be furnished at a pressure less than that which is desirable for the higher sections, and the proposed extension includes the erection of a pumping station near the boundary line at the junction of the two new mains. The necessary land has been purchased, extending from Hyde Park Avenue to the railroad, where a switch track will be laid for the delivery of coal to the station. Work has been begun upon foundations of the structure, and a contract has been made for two pumping engines, each having a capacity for pumping 3,000,000 gallons in 24 hours.

A 20-inch pipe line has also been laid, about 3,000 feet long, from the pumping station to connect with a main of the city of Boston in West Roxbury, by which water can be pumped from this station to supply the higher portions not only of Hyde Park, which has now become a part of the city of Boston, but also of West Roxbury and Milton.

It is expected that the pumping station will be completed and equipped and put into operation before the end of the year.

(4) Acquisition of Lands and Settlements for Damages.

The Board has acquired by purchase during the past year additional lands in fee amounting to 133.472 acres and has acquired by taking, easements in 0.383 of an acre. The total acquisitions of land in fee and in easement have thus amounted to 133.855 acres.

Of the lands acquired, three tracts containing 80.788 acres in West Boylston and Sterling, were situated on Waushacum Pond and

Brook; one tract containing 44.75 acres was situated on French Brook in Boylston; two tracts situated partly in Hyde Park and partly in Boston, containing 1.421 acres in fee and easements in another parcel of 0.383 of an acre, were acquired in order to provide for the laying of a pipe line, and for the erection of a pumping station for the Southern High Service; a parcel of land containing 0.21 of an acre in Natick was situated on the margin of Lake Cochituate; and a parcel containing 1.433 acres in Framingham was on Framingham Reservoir No. 2. Two remaining tracts in Boylston having an area of 4.88 acres were acquired by exchange.

The Board has conveyed away in exchange a small parcel of land in Boylston, containing 0.32 of an acre, and has granted to the Worcester County Commissioners the right to use, subject to revocation, 22 acres of land on Pleasant Street in West Boylston for forestry and agricultural purposes in connection with the Worcester County Training School.

The settlements made during the year on account of land both purchased and taken have numbered 9. The total amount paid in settlements was $12,229.03. All of these settlements were effected by voluntary agreement.

There have been 5 takings of land in fee, including a total of 54.219 acres, all of which were of parcels to which title by deed had previously been acquired, and there was made an additional taking of easements and rights in 0.383 of an acre which had not been previously acquired. Takings of temporary rights of way and occupancy of lands in Newton, in all of 3.569 acres, were made for the purpose of constructing a tunnel in connection with the Weston Aqueduct Supply Mains.

The following is a list of the takings made during the year for the Water Works: —

Takings for Metropolitan Water Works for the Year 1911.

No.	Location and Description.	Former Owner.	Recorded.	Purpose of Taking.
137	West Boylston and Clinton, — Laurel Street in West Boylston, on West Berlin road, Clinton. Area, fee in 9.245 acres.	Anna E. Russell, Lucinda E. Larkin.	1911. May 20.	Improvement of Wachusett watershed.
138	Holden,—Tietze mill property. Area, fee in 42.12 acres.	Abel C. Haynes.	May 20.	Improvement of Wachusett watershed.
139	Newton, — Additional rights of way and to occupy in extension of same rights taken May 12, 1910, relating to lands near Commonwealth and Grant avenues and Ward Street. Area, right to occupy, 2.99 acres, rights of way in 0.579 acre.	John Ward and heirs of George K. Ward, heirs of Francis Pettee, Nehemiah W. Rice *et al.*, Caroline R. Braman, Charles G. Rice.	Sept. 1.	Weston Aqueduct supply mains.
140	Hyde Park, — Hyde Park Avenue and easements in railroad location and Mansur Street and Grew Avenue. Area, fee in 1.276 acres, easements in 0.128 acre.	Eva M. Nesson, Carl Stohn and easements in location of New York, New Haven & Hartford R.R. and private ways.	Sept. 9.	Southern high-service pipe lines.
141	Boston (West Roxbury), — Parcel adjoining location of New York, New Haven & Hartford R.R. Co., westerly from Hyde Park Avenue and easements in Mansur and Burley streets. Area, fee in 0.145 acre, easements in 0.255 acre.	Eva M. Nesson and easements in private ways.	Sept. 9.	Southern high-service pipe lines.
142	Framingham, — Between Fountain Street and location of Boston & Albany R.R. Co. Area, fee in 1.433 acres.	Bridget McLaughlin and Mary Gallagher.	Nov. 24.	Framingham Reservoir, No. 2.

IV. WATER WORKS — MAINTENANCE.

(1) Operation of Works.

The maintenance and operation of the Metropolitan Water Works during the past calendar year has required the expenditure of $362,819.46.

(2) Storage Reservoirs.

The following reservoirs are maintained for the collection and storage of water in the various watersheds which serve as sources of supply for distribution to the different municipalities in the District: —

	Capacity in Gallons.
Cochituate watershed: —	
Lake Cochituate, including Dudley Pond,	2,328,300,000
Sudbury watershed: —	
Sudbury Reservoir,	7,253,500,000
Framingham Reservoir No. 1,	287,500,000
Framingham Reservoir No. 2,	529,900,000
Framingham Reservoir No. 3,	1,180,000,000
Ashland Reservoir,	1,416,400,000
Hopkinton Reservoir,	1,520,900,000
Whitehall Reservoir,	1,256,900,000
Farm Pond,	167,500,000
Wachusett watershed: —	
Wachusett Reservoir,	64,968,000,000
Total,	80,908,900,000

The various reservoirs are capable of holding in storage 80,908,900,000 gallons, but their full capacity was not reached during the year. At the beginning of the year the total quantity in storage was 59,327,000,000 gallons. The maximum quantity in storage was reached on May 2, when there were contained 67,953,900,000 gallons, a quantity less than that in any preceding year since the Wachusett Reservoir was first filled. The quantity decreased until October 18, when there were 55,503,900,000 gallons. During the latter part of the year there was a gain in storage so that on January 1, 1912, the reservoirs contained 59,980,000,000 gallons, or somewhat more than the quantity held at the beginning of the year.

At the Wachusett Reservoir high-water mark was not reached, the highest elevation of water at any time being on June 10, when the elevation was 387.41 feet, or 7.6 feet below the high-water mark of the reservoir. At the end of the year, however, the reservoir was nearly 3 feet higher than at the beginning.

Little work has been required upon the margins of the Wachusett Reservoir, but the carrying of materials and machinery in connection with the installation of the power plant at the Wachusett Dam has so worn the roadways that considerable repairs have been required. The work has been done in conjunction with the authorities of the town of Clinton and the various ways have been restored to good condition.

A small concrete building has been erected on the grounds below the Wachusett Dam for use as a garage and for a storehouse for tools used in the care of the grounds.

The Sudbury Reservoir, which receives the supply from the Wachusett Reservoir, and Framingham Reservoir No. 3, into which a portion of the Sudbury waters is discharged, were kept full or nearly full during the year in order to facilitate the furnishing of the supply to the Metropolitan District.

On account of the desire to utilize so far as practicable during the past year the waters of the Ashland, Hopkinton and Whitehall reservoirs, as well as those of Framingham Reservoir No. 2, these reservoirs have been drawn upon for considerable periods for the Metropolitan supply.

No water has been drawn from Framingham Reservoir No. 1 or from Farm Pond for Metropolitan uses, although the town of Framingham has obtained the larger part of its supply from filter galleries located on the shores of Farm Pond.

Lake Cochituate was drawn upon during the larger portion of the year for the supply of the Metropolitan District. Some further land has been acquired for increasing the margin about the lake, and a low, shallow area on the shore has been filled. The general improvement by which the surface drainage from the village of Cochituate is diverted into Bannister's Brook and the Sudbury River has been completed.

(3) AQUEDUCTS.

The Wachusett Aqueduct, through which is carried the water from the Wachusett Reservoir into the Sudbury Reservoir, was in operation a total of 198 days in the year. An average of 65,580,000 gallons per day for the entire year was drawn from the reservoir, which was less than two-thirds of the quantity drawn in the preceding year, on account of the greater utilization of the other sources of supply.

The Sudbury Aqueduct was in constant use during the year and discharged into the Chestnut Hill Reservoir 70,560,000 gallons per day, 47,768,000 gallons being drawn from the Sudbury Reservoir through Framingham Reservoir No. 3, and 22,792,000 gallons from Framingham Reservoir No. 2.

The Cochituate Aqueduct was in operation for 210 days during the year and the quantity drawn was equivalent to a daily average of 9,522,000 gallons for the entire year.

With the exception of 1½ hours on a single day the Weston Aqueduct was in continuous service and there was an average daily flow of 29,839,000 gallons for the year.

It therefore appears that a greater use has been made during the past year of the waters of both Framingham Reservoir No. 2 and the contributing reservoirs in the southern part of the Sudbury watershed, and also of the waters of Lake Cochituate which, on account of the works in progress, were not utilized at all for the Metropolitan District in the preceding year.

(4) Distributing Reservoirs.

The various distributing reservoirs and standpipes have been kept substantially full during the year not only as a protection and relief in case of accident and emergency, but also in order to secure a proper distribution of the water through the District.

Their respective locations in the different parts of the Metropolitan District and their capacities are as follows: —

	Capacity in Gallons.
Spot Pond, Stoneham and Medford,	1,791,700,000
Chestnut Hill Reservoir, Brighton district of Boston,	300,000,000
Weston Reservoir, Weston,	200,000,000
Fells Reservoir, Stoneham,	41,400,000
Mystic Reservoir, Medford,	26,200,000
Waban Hill Reservoir, Newton,	13,500,000
Forbes Hill Reservoir, Quincy,	5,100,000
Bear Hill Reservoir, Stoneham,	2,450,000
Arlington Standpipe, Arlington,	550,000
Forbes Hill Standpipe, Quincy,	330,000
Total,	2,381,230,000

(5) Pumping Stations.

Of all the water supplied to the various municipalities of the Metropolitan District 73 per cent., or nearly three-quarters, is brought to Chestnut Hill and pumped from the Chestnut Hill pumping stations. The remaining 27 per cent. is delivered by gravity into the large mains of the District. Some of the higher portions of the District are supplied by a second pumping from the Spot Pond, Arlington and West Roxbury stations.

The average quantity pumped per day during the year at the Chestnut Hill stations was 80,435,000 gallons, at the Spot Pond station 7,590,000 gallons, at the Arlington station 835,000 gallons, and at the West Roxbury station 690,000 gallons, a total of 89,550,000 gallons a day being upon the average pumped at all the stations.

The following are the several pumping stations: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Chestnut Hill High-service Station, ...	4	66,000,000	138
Chestnut Hill Low-service Station, ...	3	105,000,000	60
Chestnut Hill Low-service Station, ...	1	40,000,000	130
Spot Pond Station, ...	2	30,000,000	125
Arlington Station, ...	2	3,000,000	290
West Roxbury Station, ...	3	3,750,000	140

The total cost of operating all of the stations during the year was $97,196.68, or $2.97 per million gallons pumped, which is a slight decrease from the cost of the preceding year. Of the total cost, $58,596.44 was expended for labor and $33,197.54 for fuel.

The total amount of coal purchased during the year was 10,034.88 gross tons, of which 7,277.16 tons were bituminous, 100.93 tons anthracite, 2,107.10 tons buckwheat anthracite and 549.69 tons anthracite screenings. The average cost of bituminous coal delivered in the bins at the various stations varied from $3.90 to $4.46; the average cost of anthracite coal was $5.17; the cost of buckwheat varied from $2.69 to $4.37, and that of anthracite screenings from $2.50 to $2.72.

A change was made in the requirements of the contracts for the purchase of bituminous coal by which the number of heat units required was increased and the allowable percentage of ash was decreased. An improvement in the quality of the coal furnished resulted. The contracts for furnishing coal continue to provide that a deduction shall be made when the coal falls below the requirements and at the same time the price is increased if it is found superior to the requirements.

A new pumping engine for the high service, which is located in the low-service pumping station, has been in operation the latter part of the year.

(6) PIPE LINES.

The total length of the pipe lines owned and operated by the Board is 101.58 miles, the length of 4.56 miles having been added during the year. The Metropolitan mains are connected with local mains by which the water is distributed to the various municipalities of the District, and these local mains of 4 inches and more in diameter have a total length of 1,569.92 miles.

During the year the abolishment of the grade crossing of the Fitchburg Railroad at Webster Avenue in the city of Somerville made necessary a change in the main 48-inch pipe line which had been laid through Webster Avenue. It was necessary to raise a length of about 983 feet, and the line for this distance has been carried over the railroad on a permanent steel bridge. The pipes were raised about 17 feet at the railroad crossing. The work was performed in connection with the Boston & Maine Railroad, the more difficult parts of the work being performed directly by the Board. The entire cost of the work, including both the portion done by the Board and that done by the Railroad, was $15,616.42. For its expenditure the Board was reimbursed by the parties charged with the expense of the improvement.

The construction of a larger channel for Stony Brook at Morton Street in West Roxbury by the City of Boston compelled the building of piers for the support of the 36-inch water main which crosses the channel at this point.

No serious break in any of the pipe lines occurred during the past year, but there were 43 leaks of a minor character which have required repairing. Of these leaks 36 were due to defective joints, some at wooden joints but the larger part at leaded joints.

(7) CLINTON SEWERAGE WORKS.

The Clinton pumping station was in operation during the entire year, and though there was a considerable extension of the sewerage system in the town, the average quantity of sewage daily pumped to the filter-beds was 829,000 gallons, the same as last year. The total cost of pumping the sewage was $3,014.85, or $9.97 per million gallons pumped.

There has been an improvement in the efficiency of the filter-beds, effected by the recent construction of additional underdrains and the placing of distributors on the beds in order to secure a uniform distribution of the sewage, and the results show a decided improvement in the effluent.

The cost of maintaining the filter-beds was $3,797.52, or $12.63 per million gallons treated. The increase of the cost was due to the required increase in the rates paid to laborers.

(8) PROTECTION OF THE WATER SUPPLY.

(a) *Diversion of Surface Drainage from Lake Cochituate.*

The works which have been in progress of construction for the diversion of the surface drainage which had found its way into Lake Cochituate were completed early in the year, and the drainage is now carried to Bannister's Brook from which it flows into the Sudbury River. The work involved the building of an open channel of 5,876 feet, a channel covered with concrete for 3,454 feet, and the laying of 1,491.5 feet of 24-inch, 18-inch and 12-inch pipe. The total cost of the work was $34,558.02 and was charged to the appropriation for maintenance.

(b) *Improvement of the Wachusett Watershed.*

In addition to the acquisition of low lands situated upon Waushacum Brook, through which the waters of Waushacum ponds are carried into the Wachusett Reservoir, for the protection of the water supply the brook itself has been straightened, deepened and widened, and generally improved on both sides.

(c) *Pegan Brook Filtration Works.*

The Pegan Brook pumping station, at which is pumped the surface drainage of the thickly settled portion of the town of Natick upon filter-beds on the margin of Lake Cochituate, was in operation 193 days during the year, and a daily average of 605,310 gallons was pumped. The cost of operating the pumping station and filter-beds was $2,731.18, a cost per million gallons filtered of $12.36.

(*d*) *Marlborough Brook Filter-beds.*

The Marlborough Brook filter-beds, which have been constructed near the mouth of the Marlborough Brook as it enters the Sudbury River, are 24 in number, 16 of them being artificial beds and 8 natural beds, and they have an area of 14 acres. These beds have been sufficient to care for the entire flow of the brook, which receives the surface water from thickly settled portions of the city of Marlborough.

(*e*) *Sterling Filter-beds.*

The filter-beds constructed on the brook which flows through the central portion of the town of Sterling and into Waushacum Pond, and the smaller filter-beds at Sterling Junction, which were built to intercept the sewage of the summer cottages and to prevent the pollution of Waushacum Pond, have been successfully operated and their care has involved but little expenditure.

(*f*) *Drainage Ditches.*

No additions have been made to the ditches which have been kept in operation in order to provide a quick drainage of several of the larger swamps on the watersheds and to prevent the discoloration and deterioration of the water flowing from them, but the existing ditches have required considerable repairs and oversight during the year.

(*g*) *Sanitary Inspection and Policing.*

A constant inspection is made of all the watersheds which contribute to the supply of water to the Metropolitan District so as to prevent the existence of sources of pollution. All premises which seem to be subject to conditions which might be injurious are kept under surveillance and it is sought to remedy the troubles which are found to exist. In many cases remedies are effected by removing the cause of the pollution, by causing connections to be made with the sewers, by the building of cesspools and otherwise. There are other cases where complete remedies are more difficult and where temporary arrangements have to be made until more comprehensive measures can be adopted. At the end of the year the premises are reported as " unsatisfactory ", unless effective means have been taken to secure the prevention of pollution, or if the premises continue a menace which will require continued attention.

The great industrial development of sections of Framingham during the past year has caused the erection of many buildings on tracts where the disposal of the sewage by cesspools is difficult, and an extension of the local sewerage system is urgently called for in preventing a future pollution of the water supply.

Examination has been made of 1,515 premises on the Wachusett watershed and of 7,235 premises on the Sudbury and Cochituate watersheds, and reports have been made thereon with reference to cesspools, privy, sink and barn drainage, manufacturing wastes and sewer connections. At the end of the year it was reported that 66 of the premises in the Wachusett watershed and 113 premises in the Sudbury and Cochituate watersheds were regarded as unsatisfactory, that is, that trouble might possibly arise under unfavorable circumstances and that they required further attention.

A comparison of the tables which are furnished in the report of the Chief Engineer with those of past years would indicate that there has been a gradual improvement in the sanitary condition of the watersheds.

There were 9 cases of typhoid fever reported from the Wachusett watershed and 33 cases on the Sudbury and Cochituate watersheds. In all these cases precautions were taken to prevent the spread of the disease and the pollution of the water supply, and no trouble was experienced from them.

The sanitary inspection has been performed by William W. Locke, C.E., with two assistants, but other employés of the Board have been called upon at various times during the year to inspect conditions in different parts of the watersheds and also for the more general protection of the property of the Commonwealth.

(*h*) *Laboratory Examinations.*

Chemical examinations are made at monthly or more frequent periods by the State Board of Health of the waters in various storage reservoirs at different depths and places and of the water discharged from the pipes in various parts of the Metropolitan District, and report is made to the Metropolitan Board relative to the amounts not only of nitrogen and other substances but turbidity, sediment and color. More frequent examinations of the water taken from the various sources are made at the laboratory of the Metropolitan Board to ascertain the numbers and character of microscopical organisms contained in the various waters. The results are used both for determining the sources from which water shall be drawn from time to time for consumption and for the purpose of taking such measures as may be possible to remedy the troubles found to exist. During the past year 397 chemical examinations were made by the State Board and 2,465 microscopical and 1,174 bacterial examinations were made by the Metropolitan Board.

(9) Quality of the Water.

The water supplied to the Metropolitan District has generally been of good quality and very few complaints have been received from water takers. Owing to the fact that a larger quantity than usual has been drawn from the Sudbury and Cochituate sources the water has had a higher color than in some previous years. The growths of microscopical organisms and bacteria have been less and not of sufficient extent to cause objectionable tastes and odors in the water as drawn from the pipes throughout the District.

(10) Forestry and Moth Suppression.

It has been the policy of the Board to protect the waters of the Wachusett Reservoir by surrounding the shores by an adequate margin at least of wooded growth. In addition to the 1,800 acres already wooded, out of a total of about 4,500 acres originally acquired, 1,350 acres have been planted by the Board, principally with pines and arbor vitae seedlings. There remain about 520 acres which it is proposed to plant. During the past year, however, only about 30 acres have been newly forested, largely owing to the fact that the older nurseries have ceased to yield proper seedlings on account of exhaustion. It has been necessary to replant with new seedlings about 12.5 acres on which the trees had been destroyed by fire. The undesirable trees and brush have also been cut out on 55 acres of the land which had been previously planted with pines, and considerable thinning out of the growth has been made on a like number of acres covered with a growth of older trees.

The Flagg nursery on the south side of the reservoir has been abandoned and the land planted with white pines. There still remains a small number of arbor vitae seedlings in the Lamson nursery on the north side of the reservoir, although the larger part of the tract has also been covered with pines.

The new nursery which has been started in Oakdale now contains more than 50,000 white pine seedlings.

During the past year there have been, owing to the prevailing drought, several serious fires upon the lands of the Commonwealth in the custody of the Board. As many as 21 fires were reported upon the Wachusett watershed, and an area of more than 230 acres was burned over. These fires were particularly destructive to the small pine trees which had been planted and had attained a considerable growth. The damage occasioned was estimated at nearly $4,000, and more than three-fourths of this amount was collected from the railroad companies which were found liable for the larger part of the fires. There were 7 fires on lands surrounding the Sudbury Works and about 45 acres were burned over, but the loss occasioned was not so great.

The forest growth has suffered severely from the ravages of the gypsy and brown-tail moths and the elm-leaf beetle and pine-tree weevil, and the sum of $7,062.21 has been expended for the protection of the various lands under the custody of the Board. The region about Spot Pond has been the most infested, although the injuries have not exceeded those of past years. Much work has been called for in the vicinity of the Weston Reservoir and along the Sudbury and Wachusett aqueducts and about the Wachusett Reservoir. It has been deemed advisable to expend a considerable sum for the purchase of a large and efficient power sprayer, which has been effectively used especially in the region about Spot Pond and the Chestnut Hill and Weston Reservoirs.

It has been the endeavor to attend to the regions most infested by the moths and especially those places where the adjoining properties are cared for by their owners. It is impossible to extend the work of suppressing the moths to the more remote and extensive woodlands without calling for large appropriations. A good deal has been accomplished in the destruction of the gypsy moths, but the work of protection against the brown-tail moths has been unsatisfactory on account of the distances which they fly.

The pine-tree weevil has infested the lands about the Sudbury and Wachusett reservoirs, and much work has been done in cutting off and burning the shoots of the young pines which have been found infested. There seems to have been less injury done than during the previous year. The chestnut bark disease was discovered in the latter part of the year in the chestnut trees near the Wachusett Dam and the disease seems to have extended through many of the towns upon the Wachusett and Sudbury watersheds. Many trees have already been destroyed and it would seem that all of the chestnut trees would have to be sacrificed.

(11) Electrolysis.

There has been no substantial change taking place in relation to the injury which is occasioned to the pipe lines through the passage of currents of electricity. The various means which have been adopted, particularly the installation of wooden insulating joints on the pipe lines, to overcome or to check the troubles arising have certainly checked the injurious action at the points which have been most exposed. There have been noticeable increases in the electric currents in places where the new power stations have been put in operation near the pipe lines.

V. WATER WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1910, and ending with November 30, 1911, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

The more detailed statement of its doings required by said chapter for the calendar year 1911 in relation to the Metropolitan Water Works, is herewith presented.

The Metropolitan Water Loans authorized for the construction and acquisition of works have amounted to $42,090,000. To this sum are added the proceeds from the sale of property by the Board, and these amounted on January 1, 1912, to $298,856.71. The total amount, therefore, which the Board has been authorized to expend is $42,388,856.71. The amount of expenditures approved by the Board for payment out of the Metropolitan Water Loan Fund was, for the year 1911, $385,920.88, and the total amount so approved for payment since the beginning of the work up to January 1, 1912, has been $41,932,850.44. There was accordingly a balance remaining at the beginning of the year 1912 amounting to $456,006.27.

The Treasurer of the Commonwealth has issued from time to time, on the request of the Board, bonds to the amount of $41,738,000. These bonds were issued for terms of thirty-nine and one-half and forty years from the date of issue, and bear interest at the rate of 3 per cent. and 3½ per cent. per annum. The sinking fund established for the payment of the bonds at maturity amounted on January 1, 1912, to $8,953,437.44.

The increase in the debt, during the calendar year, as represented by the Metropolitan Water Loans outstanding, was $340,000. The increase of the sinking fund for the payment of the debt at maturity was during the same period, $863,534.53. There has been, therefore, a decrease of the net debt during the calendar year amounting to $523,534.53.

The amount approved by the Board for the maintenance and operation of the Water Works for the year 1911 which was paid out of the annual assessments, was $362,819.46.

The assessments for the year 1911 for the payment of interest on the bonds, for the sinking fund requirements and for the expenses of operation and maintenance of the Water Works, which were levied upon the various cities and towns in the Metropolitan District, amounted to $2,333,021.97.

(1) METROPOLITAN WATER LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to the proceeds of these loans, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1912, have been as follows: —

Loans authorized under acts prior to 1911,[1]	$41,778,000 00	
Loan under chapter 464 of the Acts of 1911, for the extension of the Southern High Service,	212,000 00	
		$42,090,000 00
Receipts from the sales of property applicable to the construction and acquisition of works: —		
For the year ending December 31, 1911,	$10,282 67	
For the period prior to January 1, 1911,	198,574 04	
	$208,856 71	
Receipt from town of Swampscott for admission to the Metropolitan Water District paid into Loan Fund (St. 1909, c. 320),	90,000 00	
		298,856 71
		$42,388,856 71
Amount approved by the Metropolitan Water and Sewerage Board for payments out of the Water Loan Fund: —		
For the year ending December 31, 1911,	$385,920 88	
For the period prior to January 1, 1911,	41,546,929 56	
		41,932,850 44
Balance January 1, 1912,		$456,006 27

(2) Issues of Metropolitan Water Loan Bonds.

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding $42,090,000, to be designated the "Metropolitan Water Loan," has sold bonds to the amount of $41,738,000. The list of bonds sold prior to the year 1910 is given in the Ninth Annual Report. The bonds sold in the year 1911 are as follows: —

Date of Sale.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
Jan. 30, 1911,	$200,000	3½	100.036	Jan., 1951	$72 00
Aug. 4, 1911,	40,000	3½	100.000[2]	Jan., 1951	-
Aug. 17, 1911,	100,000	3½	100.000[2]	Jan., 1951	-

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[1] For complete statement of Loans authorized prior to 1911, see Tenth Annual Report.

[2] Not issued or delivered until 1912.

Prior to May 1, 1906, all premiums received from the sales of bonds were applied to the payment of the current charges in reduction of the annual assessments, but since that date, under the provisions of chapter 337, Acts of 1906, they have been paid into the sinking fund.

(3) METROPOLITAN WATER LOAN SINKING FUND.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows: —

December 31, 1895, .	$226,286 05	December 31, 1904, .	$3,519,602 92
December 31, 1896, .	699,860 70	December 31, 1905, .	4,207,045 69
December 31, 1897, .	954,469 00	December 31, 1906, .	4,897,822 62
December 31, 1898, .	1,416,374 29	December 31, 1907, .	5,643,575 69
December 31, 1899, .	1,349,332 97	December 31, 1908, .	6,419,283 28
December 31, 1900, .	1,573,619 72	December 31, 1909, .	7,226,262 31
December 31, 1901, .	1,662,426 95	December 31, 1910, .	8,089,902 91
December 31, 1902, .	2,256,803 81	December 31, 1911, .	8,953,437 44
December 31, 1903, .	2,877,835 59		

(4) ANNUAL ASSESSMENTS AND RECEIPTS.

Assessments for the year 1911 amounting to $2,333,021.97 were required for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of operation and maintenance of the Water Works. The requirements were: for interest, $1,415,881.26; for the sinking fund, $515,369; for serial bond, $5,000; and for maintenance and operation, $396,771.71. These assessments were made by the Treasurer of the Commonwealth upon the various municipalities as follows: —

Arlington, . . .	$18,249 50	Nahant, . . .	$5,308 47
Belmont, . . .	7,439 82	Newton, . . .	6,476 92
Boston, . . .	1,825,362 87	Quincy, . . .	54,410 43
Chelsea, . . .	50,649 44	Revere, . . .	26,022 35
Everett, . . .	47,962 56	Somerville, . .	115,094 29
Hyde Park, . .	1,288 44	Stoneham, . . .	11,255 28
Lexington, . . .	8,238 55	Swampscott, . .	10,651 30
Malden, . . .	43,828 06	Watertown, . .	18,569 01
Medford, . . .	30,159 23	Winthrop, . . .	14,819 25
Melrose, . . .	21,200 18		
Milton, . . .	16,036 02		$2,333,021 97

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of these municipalities had reached the safe capacity of its own sources of water supply, and neither had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property and of water, are required by statute to be applied to the payment of the interest, the sinking fund requirements and expenses of maintenance and operation of works. These for the year 1911 amounted to $28,408.82.

The amount approved by the Board for the maintenance and operation of the Metropolitan Water Works was, for the year 1911, $362,819.46.

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1911 under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

Town of Framingham,	$1,969 15
Town of Revere (on account of water furnished to the town of Saugus for 1909 and 1910),	610 00
United States Government,	2,093 27
Town of Wakefield,	3,748 79
Westborough State Hospital,	1,588 32
City of Worcester,	1,810 76
	$11,820 29

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District, but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

Construction and Acquisition of Works.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Administration applicable to all parts of the construction and acquisition of the works, . .		$5,873 80		$294,326 87
Wachusett Dam and Reservoir: —				
Wachusett Dam, ...	$10 77		$2,378,206 05	
Power plant, ...	104,395 64		106,831 70	
Power house floor, ...	8,168 78		8,168 78	
North Dike, ...	-		792,264 68	
South Dike, ...	-		137,075 55	
Removal of soil, ...	-		2,536,612 66	
Relocation of railroads, ...	-		881,872 45	
Roads and bridges, ...	-		547,867 76	
Real estate, ...	82 85		3,240,271 91	
Damages, real estate not taken, business and loss of wages, ...	-		532,247 07	
Other expenses, ...	-		8,547 92	
		112,658 04		11,169,966 53
Improving Wachusett watershed, ...		4,505 95		235,634 72
Wachusett Aqueduct, ...		-		1,797,948 85
Sudbury Reservoir, ...		-		2,923,146 96
Protection of Sudbury supply, ...		-		129,190 36
Improving Sudbury watershed, ...		-		95,711 84
Protection of Cochituate supply, ...		-		9,000 00
Improving Cochituate watershed, ...		-		8,860 68
Improving Lake Cochituate, ...		-		104,141 29
Pipe lines, Dam No. 3 to Dam No. 1, ...		-		48,471 48
Pipe line, Rosemary siphon, ...		-		23,142 98
Weston Aqueduct: —				
Aqueduct, ...	-		$2,353,820 11	
Reservoir, ...	-		289,001 82	
Real estate, taxes and other expenses, . .	-		206,668 18	
		-		2,849,490 11
Distribution system: —				
Low service: —				
New 48-inch main, Section 31, ...	-		$162,698 06	
Section 38, Tunnel (East Boston main), . .	$16,383 39		48,705 66	
Pipe lines and connections, ...	3,178 73		1,795,163 75	
Pumping station, Chestnut Hill, ...	-		462,572 19	
Reservoir, Spot Pond, ...	-		582,188 73	
Gate-house and connections, Chestnut Hill Reservoir, ...	-		65,480 88	
Real estate and other expenses, ...	2 80		92,938 97	
Northern high service: —				
Pipe lines and connections, ...	954 10		528,439 86	
Spot Pond pumping station, ...	-		291,829 35	
Fells Reservoir, Stoneham, ...	-		141,392 94	
Bear Hill Reservoir, Stoneham, ...	-		38,267 70	
Real estate and other expenses, ...	-		14,838 05	
Amounts carried forward, ...	$ 20,519 02	$123,037 79	$4,224,516 14	$19,689,032 67

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$20,519 02	$123,037 79	$4,224,516 14	$19,689,032 67
Distribution system — *Concluded.*				
Southern high service: —				
Pipe lines and connections,	10,508 43		526,719 49	
Section 39 (Hyde Park connection),	48,759 63		48,759 63	
Pumping station, Chestnut Hill,	60,874 71		368,569 41	
Forbes Hill Reservoir, Quincy,	-		90,003 49	
Waban Hill Reservoir, Newton,	-		61,592 11	
Real estate and other expenses,	-		10,226 36	
Northern extra high service,	100 82		101,898 59	
Southern extra high service: —				
Pipe lines and connections,	70 71		22,881 81	
Hyde Park connection,				
Section 40,	29,953 48		29,953 48	
Section 41,	14,720 54		14,720 54	
Hyde Park Pumping Station,	7,358 54		7,358 54	
Real estate and other expenses,	7,032 78		7,092 95	
Weston Aqueduct supply mains,	70,589 92		1,030,015 50	
Meters and connections,	5,069 66		89,685 35	
Improving Spot Pond Brook,	-		3,991 23	
Glenwood pipe yard,	-		33,100 59	
Chestnut Hill pipe yard,	-		11,311 26	
		275,558 24		6,682,396 47
Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work: —		$398,596 03		
Amount received,	$66,949 74		$2,538,091 71	
Transferred from storage yards to the various sections of the work and included in costs of special works,	79,624 89		2,400,571 70	
				137,520 01
Deduct excess of transfers over amount purchased during year,		12,675 15		
Diversion of water, South Branch of Nashua River,[1]		-		1,363,935 31
Acquisition of existing water works: —				
Reimbursement city of Boston, partially constructed Reservoir,	-		$1,157,921 59	
Boston water works, taken January 1, 1898,	-		12,768,948 80	
Spot Pond taken from Malden, Medford and Melrose,	-		1,240,229 62	
Waban Hill Reservoir purchased from Newton,	-		60,000 00	
Amounts carried forward,	. . .	$385,920 88	$15,227,100 01	$27,872,884 46

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[1] Of the total expenditures from the beginning of the work, the sum of $150,939.89 is for Clinton sewerage system.

CONSTRUCTION AND ACQUISITION OF WORKS.		For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.	
Amounts brought forward,		$385,920 88	$15,227,100 01	$27,872,884 46
Acquisition of existing water works — *Concluded.*				
Expenses: —				
Engineering,	$22,617 52			
Conveyancing,	3,862 92			
Legal, expert and court,	46,648 03			
			73,128 47	
			15,300,228 48	
Deduct following, transferred and charged to special works: —				
Reimbursement city of Boston, transferred to Sudbury Reservoir,	$1,157,921 59			
Waban Hill Reservoir transferred to Distribution Department,	60,000 00			
Stock — pipes, engines, etc., included with Boston Water Works and transferred to Distribution Department,	22,340 91			
			$1,240,262 50	
				$14,059,965 98
Total for construction and acquisition of works,		$385,920 88		$41,932,850 44

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1911.	
Administration,		$12,414 85
General supervision,		31,561 29
Taxes and other expenses,		35,909 55
Wachusett Reservoir Department: —		
Superintendence,	$8,234 25	
Reservoir,	5,296 11	
Forestry,	6,449 94	
Protection of supply,	3,669 03	
Buildings and grounds,	5,044 19	
Wachusett Dam,	6,068 44	
Wachusett Aqueduct,	4,868 95	
Clinton sewerage system: —		
Pumping station,	2,894 16	
Sewers, screens and filter-beds,	3,943 59	
Sanitary inspection,	867 43	
Swamp drainage,	2,714 26	
Power plant,	2,399 27	
		52,449 62
Amount carried forward,		$132,335 31

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1911.	
Amount brought forward,	. . .	$132,335 31
Sudbury Department: —		
Superintendence, Framingham office,	$10,121 63	
Ashland Reservoir,	1,249 19	
Hopkinton Reservoir,	1,599 24	
Whitehall Reservoir,	498 80	
Framingham Reservoirs Nos. 1, 2 and 3,	7,015 35	
Sudbury Reservoir,	5,538 34	
Lake Cochituate,	4,608 66	
Marlborough Brook filters,	1,443 63	
Pegan filters,	2,720 15	
Sudbury and Cochituate watersheds,	715 54	
Sanitary inspection,	3,143 51	
Cochituate Aqueduct,	4,047 36	
Sudbury Aqueduct,	6,966 19	
Weston Aqueduct,	4,987 60	
Improving Lake Cochituate,	7,674 58	
		62,329 77
Distribution Department: —		
Superintendence,	$4,506 68	
Arlington pumping station, pumping service,	6,958 61	
Chestnut Hill low-service pumping station, pumping service,	38,235 86	
Chestnut Hill high-service pumping station, pumping service,	33,202 50	
Spot Pond pumping station, pumping service,	12,180 45	
West Roxbury pumping station, pumping service,	6,203 76	
Arlington standpipe,	45 00	
Bear Hill Reservoir,	143 00	
Chestnut Hill Reservoir and grounds,	10,769 82	
Fells Reservoir,	708 54	
Forbes Hill Reservoir,	1,926 19	
Mystic Lake, conduit and pumping station,	1,900 23	
Mystic Reservoir,	915 74	
Waban Hill Reservoir,	298 25	
Weston Reservoir,	2,536 63	
Spot Pond,	7,632 53	
Buildings at Spot Pond,	159 14	
Pipe lines: —		
Low service,	15,568 18	
Northern high service,	3,629 42	
Southern high service,	4,459 18	
Supply pipe lines,	755 01	
Buildings at Chestnut Hill Reservoir,	1,508 13	
Chestnut Hill pipe yard,	1,841 10	
Glenwood pipe yard and buildings,	3,897 55	
Stables,	5,641 32	
Venturi meters,	919 58	
Measurement of water,	1,273 47	
Arlington pumping station, buildings and grounds,	338 51	
		168,154 38
Total for maintaining and operating works,	. . .	$362,819 46

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1911.

(a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1911, and ending December 31, 1911, is $385,920.88, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1911, is $41,932,850.44.

For maintenance and operation the expenditures for the year have been $362,819.46, and from the beginning of the work, $4,587,988.24.

The salaries of the commissioners, and the other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.		
Administration.		
Commissioners,	$2,333 33	$123,143 58
Secretary and auditor,	750 00	51,342 03
Clerks and stenographers,	1,709 37	64,342 21
Legal services,	-	2,359 00
Traveling,	38 30	3,712 87
Stationery and printing,	452 20	13,700 22
Postage, express and telegrams,	140 00	3,057 17
Furniture and fixtures,	95	4,289 59
Alterations and repairs of buildings,	59	5,791 56
Amounts carried forward,	$5,424 74	$271,788 23

General Character of Expenditures.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$5,424 74		$271,738 23	
Administration — Concluded.				
Telephone, lighting, heating, water and care of building,	271 93		12,201 27	
Rent and taxes, main office,	146 20		5,767 69	
Miscellaneous expenses,	30 93		4,619 68	
		$5,873 80		$294,326 87
Engineering.				
Chief engineer and department engineers,	$76 92		$207,548 28	
Principal assistant engineers,	2,371 46		163,485 64	
Engineering assistants,	12,592 70		1,058,585 59	
Consulting engineers,	520 00		26,135 07	
Inspectors,	5,275 15		308,746 20	
Architects,	-		36,161 19	
Railroad and street car travel,	172 07		27,751 20	
Wagon hire,	-		45,337 53	
Stationery and printing,	268 04		27,021 12	
Postage, express and telegrams,	1 00		7,731 00	
Engineering and drafting instruments and tools,	224 35		19,533 88	
Engineering and drafting supplies,	85 42		25,104 93	
Books, maps and photographic supplies,	117 39		7,167 32	
Furniture and fixtures,	1 65		14,980 11	
Alterations and repairs of buildings: —				
Main office,	1 79		14,111 09	
Sub-offices,	-		2,939 36	
Telephone, lighting, heating, water and care of buildings: —				
Main office,	815 88		27,270 35	
Sub-offices,	3 00		19,670 82	
Rent and taxes, main office,	438 60		17,071 55	
Rent of sub-offices and other buildings,	-		4,526 74	
Field offices and sheds,	-		1,274 49	
Clinton office building,	-		9,866 87	
Unclassified supplies,	-		8,264 87	
Miscellaneous expenses,	397 50		9,390 25	
		23,362 92		2,089,675 45
Construction.				
Preliminary work (borings, test pits and other investigations): —				
Advertising,	$88 08		$6,749 97	
Labor,	73 48		118,831 80	
Other preliminary work as given in detail in preceding annual report,	-		36,699 09	
		161 56		162,280 86
Contracts, Wachusett Reservoir: —				
Contracts completed and final payments made prior to January 1, 1911,	-		$5,406,738 30	
McBride & Co., Stillwater improvement,	-		23,314 67	
Sundry bills paid under this contract,	-		3,552 11	
Amounts carried forward,	. . .	$29,398 28	$5,433,605 08	$2,546,283 18

General Character of Expenditures.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	. . .	$29,398 28	$5,433,605 08	$2,546,283 18
Construction — Con.				
Contracts, Wachusett Reservoir — *Con.*				
For Power Plant: —				
Builders Iron Foundry, castings,	$1,562 85		$1,562 85	
Builders Iron Foundry, Venturi meters,	3,750 00		3,750 00	
Davis & Farnum Mfg. Co., castings,	1,610 56		1,610 56	
The Fairbanks Co., hydraulic lift valves,	5,108 00		5,108 00	
Florence Iron Works, castings,	2,561 68		2,561 68	
Niles-Bement Pond Co., traveling crane,	2,500 00		2,500 00	
S. Morgan Smith Co., hydraulic turbine,	1,250 00		1,250 00	
Standard Underground Cable Co., cables,	1,378 10		1,378 10	
U.S. Cast Iron Pipe and Foundry Co., castings,	1,340 64		1,340 64	
S. Morgan Smith Co., hydro electric plant,	61,539 62		61,539 62	
		82,601 45		5,516,206 53
Contracts completed, improving Wachusett Watershed,		-		11,893 75
Contracts completed, Wachusett Aqueduct,		-		1,447,208 55
Contracts completed, Sudbury Reservoir,		-		1,545,028 33
Contracts completed, protection Sudbury supply,		-		9,000 00
Contracts completed, improving Lake Cochituate,		-		60,657 45
Contracts completed, protection Cochituate supply,		-		9,000 00
Contracts completed, Rosemary siphon,		-		5,916 96
Contracts completed, pipe line, Dam No. 3 to Dam No. 1,		-		17,240 22
Contracts completed, Clinton sewerage system,		-		66,878 22
Contracts, Weston Aqueduct: —				
Contracts completed and final payments made prior to January 1, 1911,		-		2,376,004 54
Contracts, Distribution System: —				
Contracts completed and final payments made prior to January 1, 1911,	-		$4,981,287 94	
James L. Bryne, laying water pipes Sect. 40, southern extra high service,	$12,292 15		12,292 15	
Builders Iron Foundry, Venturi meters and recorders,	1,474 40		1,474 40	
Chas. M. Callahan, laying water pipes Sect. 35, northern extra high service,	225 92		4,518 30	
The Hodge Boiler Works, 80-inch steel pipes for Weston Aqueduct supply mains,	3,725 57		3,725 57	
Robb Mumford Boiler Co. (Robb Eng. Co., Ltd., Assignee) two boilers for Chestnut Hill low-service pumping station,	10,448 00		10,448 00	
Michael Russo, laying water pipes on Sect. 37, low-service pipe lines,	1,262 92		13,086 10	
Standard Cast Iron Pipe and Foundry Co., special castings,	2,378 84		5,988 45	
Amounts carried forward,	$31,807 80	$111,999 73	$5,032,820 91	$13,611,317 73

General Character of Expenditures.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$31,807 80	$111,999 73	$5,032,820 91	$13,611,317 73
Construction — Con.				
Contracts, Distribution System — Con.				
B. F. Sturtevant Co., fuel economizer for Chestnut Hill low-service pumping station,	1,740 00		1,740 00	
U. S. Cast Iron Pipe and Foundry Co., special castings,	57,267 67		57,267 67	
Camoia & Williams, laying water pipes on Sect. 33, northern high service,	489 29		14,721 27	
Cavanagh Bros., laying water pipes on Sect. 6, Weston Aqueduct supply mains,	3,916 67		40,577 77	
Andrew M. Cusack, laying water pipes on Sect. 41, southern extra high service,	3,755 40		3,755 40	
De Vincenzi & Baruffoldi, laying water pipes on Sect. 36, northern extra high service,	-		3,233 31	
Joseph Hanreddy, laying water pipes on Sect. 7, Weston Aqueduct supply mains,	49,755 75		102,055 94	
Holly Manufacturing Co., pumping engine for Chestnut Hill high-service pumping station,	35,000 00		85,000 00	
Pratt & Cady Co., water valves,	3,603 15		3,603 15	
Michael Russo & Son, for laying water pipes on Sect. 39, southern high service,	13,583 30		13,583 30	
		200,919 03		
			$5,358,358 72	
Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900,	-		3,139 77	
				5,355,218 95
Additional work: —				
Labor,	$32,206 03		$828,812 75	
Professional services, medical services, analyses, etc.,	827 75		4,508 74	
Traveling,	67 63		2,815 43	
Rent,	245 00		4,322 22	
Water rates,	-		1,454 77	
Freight and express,	637 60		14,500 17	
Jobbing and repairing,	503 89		10,449 97	
Tools, machinery, appliances and hardware supplies,	5,857 47		90,101 44	
Electrical supplies,	1,759 93		7,323 86	
Castings, ironwork and metals,	4,082 66		91,341 69	
Iron pipe and valves,	4,552 38		80,314 78	
Blasting supplies,	-		1,950 15	
Paint and coating,	872 52		5,471 98	
Fuel, oil and waste,	483 23		12,661 35	
Lumber and field buildings,	1,661 27		91,673 15	
Drain pipe,	321 36		9,557 16	
Brick, cement and stone,	3,794 45		35,292 40	
Sand, gravel and filling,	903 48		8,506 83	
Amounts carried forward,	$58,776 65	$312,918 76	$1,301,058 84	$18,966,536 68

General Character of Expenditures.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$58,776 65	$312,918 76	$1,201,058 84	$18,966,536 68
Construction — Con.				
Additional work — *Con.*				
Municipal and corporation work,	145 67		220,810 34	
Police service,	-		210,801 74	
Sanitary inspection,	-		13,107 09	
Judgments and settlements for damages,	-		53,124 26	
Unclassified supplies,	1,045 11		19,023 41	
Miscellaneous expenses,	1,398 31		7,552 56	
		61,365 74		1,825,478 24
Legal and expert: —				
Legal services,	-		$4,668 82	
Expert services,	-		1,862 66	
Court expenses,	-		1,317 20	
Miscellaneous expenses,	-		185 80	
		-		8,034 48
Real Estate.				
Legal and expert: —				
Legal services,	-		$4,736 31	
Conveyancer and assistants,	$217 00		110,861 97	
Experts,	-		18,008 93	
Appraisers,	75 00		22,407 75	
Court expenses,	-		11,139 43	
Counsel expenses,	-		43 25	
Conveyancing supplies,	3 00		3,193 53	
Conveyancing expenses,	39 35		6,017 29	
Miscellaneous expenses,	8 00		4,334 15	
Settlements made by Board,	11,294 03		3,439,659 10	
Judgments,	-		170,716 24	
Taxes and tax equivalents,	-		68,182 41	
Care and disposal,	-		86,901 14	
		11,636 38		3,946,201 50
Damages to Real Estate not taken, to Business and on Account of Loss of Wages.				
Legal and expert: —				
Legal services,	-		$1,130 67	
Expert services,	-		2,857 62	
Court expenses,	-		15,394 34	
Miscellaneous expenses,	-		125 00	
Settlements,	-		415,513 65	
Judgments,	-		116,733 42	
		-		551,754 70
Claims on Account of Diversion of Water.				
Legal and expert: —				
Legal services,	-		$3,774 98	
Expert services,	-		19,339 69	
Amounts carried forward,		$385,920 88	$23,114 67	$25,298,005 60

General Character of Expenditures.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	. . .	$385,920 88	$23,114 67	$25,298,005 60
Claims on Account of Diversion of Water — Con.				
Legal and expert — *Con.*				
Court expenses,	-		20,775 49	
Miscellaneous expenses,	-		1,289 58	
Settlements,	-		917,350 00	
Judgments,	-		220,969 67	
		-		1,183,499 41
Purchase of Existing Water Works.				
Legal and expert: —				
Legal services,	-		$1,878 89	
Expert services,	-		13,569 82	
Court expenses,	-		29,728 38	
Miscellaneous expenses,	-		1,470 94	
Settlements and judgments,	-		15,227,100 01	
		-		15,273,748 04
Relocation Central Massachusetts Railroad.				
Settlements,		-		177,597 39
Total amount of construction expenditures,	. . .	$385,920 88		$41,932,850 44

General Character of Expenditures.	For the Year ending December 31, 1911.	
Maintenance and Operation of Works.		
Administration: —		
Commissioners,	$4,666 67	
Secretary and assistants,	5,110 80	
Rent,	542 38	
Repairs of building,	70 52	
Fuel,	42 19	
Lighting,	37 18	
Care of building,	350 37	
Postage,	-	
Printing, stationery and office supplies,	1,454 82	
Telephones,	75 89	
Traveling expenses,	109 68	
Miscellaneous expenses,	70 10	
		$12,530 60
General supervision: —		
Chief engineer and assistants,	$25,611 00	
Rent,	1,627 20	
Amounts carried forward,	$27,238 20	$12,530 60

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
Amounts brought forward,	$27,238 20	$12,530 60
MAINTENANCE AND OPERATION OF WORKS — *Con.*		
General supervision — *Con.*		
Repairs of building,	607 59	
Fuel,	126 56	
Lighting,	112 34	
Care of building,	1,051 16	
Postage,	154 00	
Printing, stationery and office supplies,	665 10	
Telephones,	329 18	
Traveling expenses,	521 50	
Miscellaneous expenses,	755 66	
		31,561 29
Pumping service: —		
Labor,	$58,596 44	
Fuel,	33,197 54	
Oil, waste and packing,	1,405 88	
Repairs,	1,590 29	
Small supplies,	1,226 38	
Rent, West Roxbury pumping station,	764 65	
		96,781 18
Reservoirs, aqueducts, pipe lines, buildings and grounds: —		
Superintendents,	$6,784 97	
Engineering assistants,	8,714 77	
Sanitary inspectors,	3,187 66	
Labor, pay roll,	126,194 17	
Labor, miscellaneous,	1,970 21	
Alterations and repairs of pumping stations,	382 43	
Alterations and repairs of other buildings and structures,	1,452 49	
Automobiles,	1,874 70	
Brick,	223 30	
Brooms, brushes and janitor's supplies,	89 13	
Castings, ironwork and metals,	1,419 44	
Cement and lime,	526 40	
Drafting and photo supplies,	172 34	
Fertilizer and planting material,	1,230 17	
Freight and express,	326 27	
Fuel,	2,890 56	
Gypsy moth supplies,	2,044 34	
Hardware,	727 79	
Hay and grain,	1,922 19	
Horses,	262 50	
Lighting,	477 05	
Lumber,	1,860 08	
Machinery,	4 91	
Paints and oils.	945 12	
Amounts carried forward,	$165,682 99	$140,873 07

General Character of Expenditures.	For the Year ending December 31, 1911.	
Amounts brought forward,	$165,682 99	$140,873 07
Maintenance and Operation of Works — *Con.*		
Reservoirs, aqueducts, pipe lines, buildings and grounds — *Con.*		
Pipe and fittings,	1,463 39	
Postage,	98 14	
Printing, stationery and office supplies,	782 99	
Rubber and oiled goods,	90 15	
Stable expenses,	966 98	
Sand, gravel and stone,	1,021 32	
Traveling expenses,	2,366 14	
Telephones,	928 32	
Teaming,	973 03	
Tools and appliances,	1,390 85	
Vehicles, harnesses and fittings,	814 07	
Municipal and corporation work,	39 43	
Miscellaneous expenses,	2,929 36	
Contracts: —		
Henry Spinach Contracting Co., contract 19-M, improvement of Lake Cochituate (surface-water drains in Framingham, Natick and Wayland),	5,355 43	
Builders Iron Foundry, contract 337-M, for one Venturi meter for Reservoir Department,	1,250 00	
		186,152 59
Payments in lieu of taxes,		35,793 80
Total expenditures for maintenance and operation,		$362,819 46

(*b*) *Receipts.*

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1911, and ending December 31, 1911, is $50,511.78, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1911, is $765,484.84. The general character of these receipts is as follows: —

General Character of Receipts.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
For distribution back to District: —				
Fees for admission to District,	-		$92,265 00	
Water furnished to cities and towns outside of District,	-		90,454 77	
Water furnished to water companies,	-		37,145 88	
		-		$219,865 65
To the credit of the loan fund: —				
Real estate and buildings,	$35 00		$44,074 34	
Tools, supplies and reimbursements,	10,247 67		164,782 37	
District entrance fees (Swampscott),	-		90,000 00	
		$10,282 67		298,856 71
To the credit of the maintenance fund: —				
Tools, supplies and reimbursements,	$20,002 87		$46,778 94	
		20,002 87		46,778 94
To the credit of the sinking fund: —				
Water furnished to cities and towns outside of District and to water companies,	$11,820 29		$32,619 04	
Forfeiture for contracts awarded but not executed,	-		500 00	
Rents,	1,624 32		95,697 10	
Land products,	6,675 03		67,601 89	
Unclassified receipts and interest,	106 60		3,565 51	
		20,226 24		199,983 54
Total receipts,		$50,511 78		$765,484 84

The foregoing receipts have been credited to the various objects or works, as follows: —

Sources of Receipts.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton, Lexington and Swampscott),	-		$182,265 00	
Supplying water to cities and towns outside of Water District (Swampscott, Revere, Lexington, Wakefield, Cambridge, Framingham, Westborough State Hospital, Worcester and U. S. Government), and to water companies (Framingham, Milton and Revere),	$11,820 29		160,219 69	
		$11,820 29		$342,484 69
Amounts carried forward,		$11,820 29		$342,484 69

Sources of Receipts.	For the Year ending December 31,1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,		$11,820 29		$342,484 69
Construction and acquisition of works: —				
Administration,	$58 54		$343 60	
Wachusett Dam,	277 32		7,189 57	
Wachusett Reservoir,	326 94		140,369 11	
Wachusett Aqueduct,	-		5,204 70	
Weston Aqueduct,	-		5,200 13	
Sudbury Reservoir,	-		10,640 42	
Distribution system,	9,656 89		110,997 48	
Diversion of water, Clinton sewerage system,	21 52		1,389 46	
Purchase of existing water works,	-		18,119 08	
		10,341 21		299,453 55
Maintenance and operation of works: —				
Administration,	$125 03		$346 42	
General supervision,	752 25		2,005 01	
Wachusett Aqueduct,	2,065 55		7,039 33	
Wachusett Reservoir,	7,530 54		40,649 21	
Power plant,	7,150 76		7,150 76	
Sudbury system,	2,076 64		19,761 11	
Distribution system,	8,177 24		40,779 70	
Clinton sewerage system,	472 27		5,815 06	
		28,350 28		123,546 60
Total receipts,		$50,511 78		$765,484 84

(*c*) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

(*d*) *Liabilities.*

The sums due on monthly pay rolls amount to $1,597.42, and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

Name.	Work.	Amount.
McBride & Co.,	Contract 283, Stillwater improvement, Wachusett Reservoir.	$778 09[1]
Camoia & Williams,	Contract 308, Section 33 of northern high-service pipe lines, Distribution System.	200 00
De Vincenzi & Baruffoldi,	Contract 322, Section 36 of northern extra high-service pipe lines, Distribution System.	100 00
Joseph Hanreddy,	Contract 314, Section 7 of the Weston Aqueduct supply mains.	9,774 58
Cavanagh Bros.,	Contract 323, Section 6 of the Weston Aqueduct supply mains.	200 00
Michael Russo & Son,	Contract 341, Section 39 of southern high-service pipe lines, Distribution System.	2,397 05
Holly Manufacturing Company,	Contract 312, pumping engine for Chestnut Hill low-service pumping station.	14,769 00
Andrew M. Cusack,	Contract 344, Section 41 of the southern extra high-service pipe lines, Distribution System.	662 72
Pratt & Cady Co.,	Contract 340, water valves for Distribution System,	635 85
S. Morgan Smith Co.,	Contract 330, hydro-electric plant at Wachusett Dam in Clinton, Mass.	6,850 00

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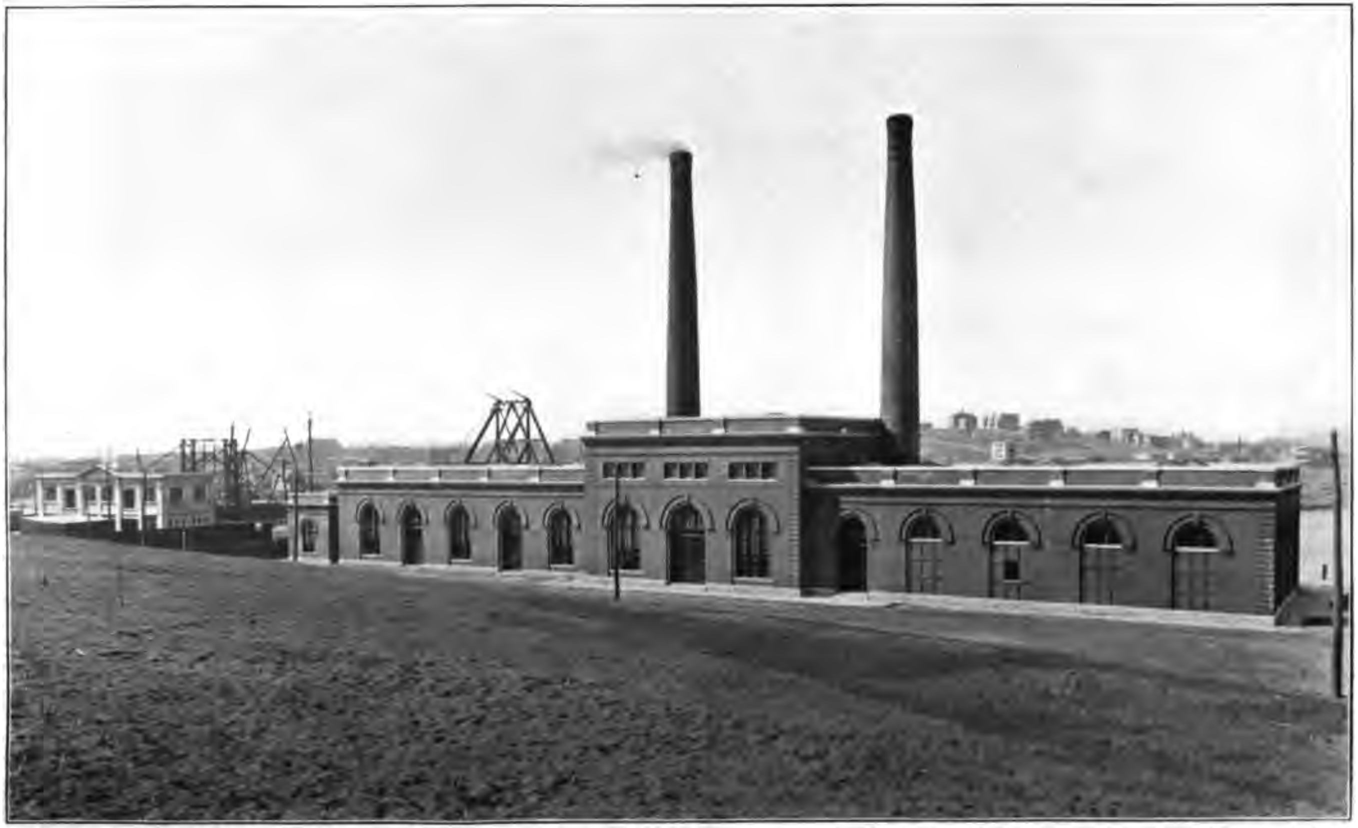
[1] Held pending settlement of claims on account of this contract.

It is impossible to state the amounts due on the claims of the following for land damages, for water rights taken and for damages to established business, as no sums have been agreed upon, and suits are now pending in court for the determination of most of them: —

Patrick Bradley, Henry F. Keyes, James E. Welch, Byron D. Allen, J. Frank Wood *et al.,* Asa Knight, Edward F. Merriam, Sanford C. Kendall, estate of William H. Vickery, James H. and Hannah S. Wood, Francis W. M. Goodale, heirs of Willard Morse, Caroline R. Braman, Charles G. Rice, Nehemiah W. Rice *et al.,* John Ward *et al.,* heirs of George K. Ward, heirs of Francis Pettee, William F. Harbach *et al.,* Royal S. Wentworth *et al.,* trustees.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville and Woburn, and the towns of Arlington, Belmont, Revere, Stoneham, Wakefield, Winchester and Winthrop, and parts of the city of Boston and the town of Lexington, — comprising in all 9 cities and 8 towns, with an area of 90.50 square miles. The District has an estimated population, based upon the United States Census of 1910, as of December 31, 1911, of 545,870. Of the total population



EAST BOSTON PUMPING STATION AS EXTENDED, WITH NEW STABLE AND LOCKER BUILDING AT LEFT.

it is estimated that 88 per cent., or 480,600 people contribute sewage to the North Metropolitan System. The total cost of the North Metropolitan Sewerage Works has been $6,686,891.50.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Milton and Watertown, and parts of the city of Boston (including the former town of Hyde Park) and the town of Dedham, — a total of 4 cities and 4 towns. This district has an area of 100.87 square miles, with an estimated population as of December 31, 1911, of 370,580. According to the estimates made 65.3 per cent. of this population, or 241,865, contribute sewage to the South Metropolitan System. The total expenditures for construction of the South Metropolitan Sewerage Works have amounted to $8,813,232.53.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the North Metropolitan Sewerage System during the past year was $165,695.35. The works under active construction during the year were the extension of the East Boston pumping station, the erection of a stable and locker building at East Boston, and the Malden and Everett sewer extension.

The work of extending the Deer Island pumping station and installing a new pumping engine with its equipment of boilers and other apparatus was substantially completed in the preceding year, but there was expended on account of the extension, largely in settlement of contracts, the sum of $19,625.38. The total cost of the additions to the building and equipment was $195,373.14.

(*a*) *East Boston Pumping Station Extension.*

The repairs and extensions to the East Boston pumping station which have been in progress were brought so near to completion during the preceding year that the building and wharf have been in entire use and the engine has been in active operation for regular service for the last three months of the past year. The new pumping engine, which has a capacity for pumping 100,000,000 gallons of sewage per day with a vertical lift of 19 feet, received its final test on December 1, 1911. The test was successful and the engine developed a duty slightly in excess of that guaranteed by the contractors.

The sum of $78,913.36 was expended during the past year on account of the appropriation for the extension, and the total expenditures have amounted to $242,438.27. This total included $143,633.55 as the cost of the building extension, $8,801.87 as the cost of the pile wharf, and $90,002.85 as the cost of the pumping engine and apparatus.

Some rearrangement of the screens and screen-house will at least be required. The original plans of the Board contemplated the installation of entirely new screening machinery with the acquisition of some additional land in connection with the work. The present screens are operated disadvantageously under ground, and their operation is difficult and unsanitary as well as expensive and uneconomical.

(*b*) *East Boston Stable and Locker Building.*

A beginning had been made in the preceding year in the erection of a building for stable and locker purposes in East Boston on a lot between Chelsea Street and the Grand Junction Railroad, which separates the lot from the East Boston pumping station. The new building has a length of 65 feet and a width of 28 feet, and is two stories in height. It is built of reinforced concrete and is believed to be fireproof. It has accommodations in the stable for 5 horses, and the locker portion constitutes the chief headquarters for the maintenance and repair forces of the North Metropolitan System. The sum of $4,524.40 was expended for the purchase of the land, and a further sum of $14,166.75 has been expended in the erection and equipment of the building.

(*c*) *Malden and Everett Sewer Extension.*

In accordance with the provisions of chapter 512 of the Acts of 1911, the Board purchased from the city of Malden the main sewer extending in Eastern Avenue from the corner of Bryant Street to Broadway, and constructed a new sewer in Broadway from Eastern Avenue to the boundary line between the city of Malden and the city of Everett. The sewer purchased was about 5,000 feet in length, in part 30 inches in diameter and in part 24 inches; and the new sewer constructed in Broadway extends a distance of 2,632 feet, all an 18-inch pipe sewer except 112 feet which consists of 12-inch pipe. The extension was made particularly for the purpose of providing for the drainage of about 80 acres in the southeasterly portion of Malden and about 80 acres in the northerly section of Everett. Under the act the Board was authorized to pay to the city of Malden the actual cost of its sewer in Eastern Avenue which was taken, amounting to the sum of $36,480.08, and the cost of the sewer constructed has amounted to $21,290.62. Inasmuch as this extension was built for the special benefit of the two cities, it is provided by the act that the Treasurer of the Commonwealth shall, in addition to levying the assessment required by law to meet the interest and sinking fund requirements of the North Metropolitan System, assess annually upon the two cities in equal shares such sums as may be necessary to satisfy the interest and sinking fund requirements of the additional bonds which were issued for carrying out this improvement.

(2) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

But little construction was performed during the last year in the South Metropolitan Sewerage System, the amount expended being $20,452.89. Nearly all of this sum was expended upon the Quincy sewage lifting station which had been nearly completed at the close of the preceding year. The building was ready for operation early in the past year and a few houses in the Hough's Neck section have been connected with the local sewer, from which the sewage is lifted so as to be carried into the High-level Sewer. This lifting station is operated by electricity generated at the Nut Island screen-house. It is expected that the city of Quincy will avail itself of the station to a greater extent during the coming year. The amount already expended on account of the station has been $24,044.60.

(3) ACQUISITION OF LAND AND SETTLEMENTS.

The Board acquired by taking under the act of the Legislature the main sewer of the city of Malden in Eastern Avenue and a settlement was effected by the payment of the sum of $36,480.08. A taking was also made of the right to construct the sewer in Broadway in the city of Malden.

Takings for Metropolitan Sewerage Works for the Year 1911.

No.	LOCATION AND DESCRIPTION.	Former Owner.	Recorded.	Purpose of Taking.
25	Malden, — Existing sewer in Eastern Avenue from Bryant Street to Broadway, a distance of 4,799 feet, and rights to maintain, repair, etc., the same.	City of Malden.	1911. June 19.	Additional outlet for sewage of Malden and Everett, North Metropolitan System.
26	Malden, — Right to construct, maintain, etc., sewer in Broadway, from Eastern Avenue to Everett boundary line, a distance of about 2,654 feet.	Public street.	June 19.	Additional outlet for sewage of Malden and Everett, North Metropolitan System.

(4) NORTH METROPOLITAN SYSTEM — MAINTENANCE.

The cost of the maintenance and operation of the North Metropolitan Sewerage Works during the past year was $149,163.19, which included the sum of $865 expended in completing the repairs on the East Boston pumping station under the special appropriation of $40,000.

(a) *Sewers and Pumping Stations.*

The length of the Metropolitan sewers in the North Metropolitan System is now 59.92 miles, and the local sewers connected with the Metropolitan sewers have a length of 683.05 miles, involving 71,860 connections.

The sewage before it is finally disposed of in the harbor off Deer Island is lifted, the most of it at least twice and a portion three times, by pumping at the four stations, the Alewife Brook, Charlestown, East Boston and Deer Island pumping stations.

The daily average amount of sewage discharged into the harbor from the Deer Island outlet was 52,800,000 gallons, which was a daily average for each individual of the population contributing sewage of 109.8 gallons. This daily average is made larger from the fact that a considerable number of the local sewers permit the direct introduction of rain water. The total amount of the discharge is 6,200,000 gallons per day less than that of the preceding year, a decrease which is principally accounted for by the conditions of the rainfall. The maximum amount of sewage discharged in any one day in the year was 103,000,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Deer Island Station,	4	235,000,000	19
East Boston Station,	4	235,000,000	19
Charlestown Station,	3	104,000,000	11 8
Alewife Brook Station,	3	22,000,000	13

There were obtained for the operation of the pumping stations 6,900.27 tons of bituminous coal, which was purchased at average prices at the different stations varying from $3.79 to $4.47 per gross ton delivered in the bins.

The sums expended for the labor of engineers and their assistants in the various pumping stations of the district amounted to $58,005.81, and for fuel amounted to $27,133.44. The total expenditure for the operation of the stations was $95,568.09.

The average cost per million gallons of sewage lifted per foot at the several stations was $0.135.

(*b*) *Siphons.*

The siphon introduced in the Metropolitan sewer in Cambridge by the building of the subway of the Boston Elevated Railway Company, and the siphon called for in the sewer crossing the Alewife Brook in Arlington in order to conform to the improvements made by the Metropolitan Park Commission, have required constant cleaning and flushing, and a gang of 5 men has been regularly employed for a portion of the week for this purpose. Their labor has added $1050 to the cost of the maintenance of the North Metropolitan System.

(*c*) *Tanneries and Gelatine and Glue Works.*

The oversight and care of the Metropolitan sewers, which receive the sewage and waste material discharged from the tanneries and other manufactories in Winchester, Woburn and Stoneham, have involved the employment of a special force consisting of a foreman and 5 men. Constant cleaning and flushing are required in order that the sewers shall not be clogged, and the settling tanks which have been introduced at the various establishments, in which the most objectionable matter is deposited before the contents are allowed to enter the sewers, call for continuous inspection. The semi-liquid sludge removed from the tanks for disposal amounted in the year to about 6,500 cubic yards. The cost attending this work is so great as to make the present situation a serious burden to the North Metropolitan Sewerage District.

(5) SOUTH METROPOLITAN SYSTEM — MAINTENANCE.

The entire cost of maintenance during the past year has been $100,399.39.

Sewers and Pumping Stations.

The Metropolitan sewers in the South Metropolitan System have a length of 43.42 miles, and with these are connected local sewers having a length of 557.52 miles, involving 34,415 connections.

The pumping stations operated for the South Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Ward Street Station,	2	100,000,000	45
Quincy Station,	3	18,000,000	28
Quincy Sewage Lifting Station,	2	3,000,000	20

The larger part of the sewage of the District is lifted into the High-level Sewer at the Ward Street pumping station in Roxbury, but the sewage of the city of Quincy is pumped into the sewer at Greenleaf street near the Quincy pumping station. The entire sewage is screened at the Nut Island screen-house for the purpose of intercepting solid matter and is thence discharged at the bottom of the harbor about a mile off from the Island.

The average daily amount of the sewage thus discharged was 42,000,000 gallons, and the largest discharge in a single day was 137,500,000 gallons. The increase in the daily average from last year was 2,400,000 gallons.

The daily average discharge of sewage for each individual contributing sewage in the District was 173.6 gallons.

There were 2,799.65 gross tons of bituminous coal obtained at the two pumping stations and screen-house, which was purchased at average prices varying from $4.09 to $4.47 per gross ton delivered in the bins.

The expenditures for the labor of the engineers and their assistants at the three stations amounted to $33,968.07, and the expenditures for fuel amounted to $11,511.33. The total amount expended for the operation of the stations was $51,563.05.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with the thirtieth day of November, 1911, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1911 is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan Sewerage Loans authorized for the construction of the Sewerage Works of the North Metropolitan System have amounted to $6,635,865.73, to which are added receipts from various sources amounting to $64,560.64. The amount of expenditures approved by the Board for payment for the year 1911 was $165,695.35, and the total amount of expenditures approved to January 1, 1912, was $6,686,891.50. The balance remaining on January 1, 1912, was $13,534.87.

The loans authorized for the construction of the various parts of the South Metropolitan System have amounted to $8,867,046.27. The receipts applicable to the loan fund have been $13,632.51. The amount of expenditures approved for payment in the year 1911 was $20,452.89. The total amount of expenditures approved for payment from the beginning of the works has been $8,813,232.53. The balance remaining for the South Metropolitan System on January 1, 1912, was $67,446.25.

The bonds issued on account of the loans have been for varying periods, not exceeding forty years, and bear interest at the rate of 3 per cent. and 3½ per cent. The premiums received on account of the sale of bonds for the North Metropolitan System have amounted to $179,547.35, and those received on account of the South Metropolitan System have amounted to $410,132.03.

The increase in the debt during the calendar year, as represented by the Metropolitan Sewerage Loans, was $62,000.00. The increase of the sinking fund for the payment of the debt at maturity was, during the same period, $252,933.09. There has consequently been a decrease in the net debt during the calendar year amounting to $190,933.09.

The amount expended for maintenance of the North Metropolitan System in the year 1911 was $149,163.19, and for the South Metropolitan System $100,399.39, a total for both systems of $249,562.58.

The assessments made to meet interest, sinking fund requirements and maintenance and operation of the North Metropolitan System amounted in the year 1911 to $463,311.33, and the assessments for the South Metropolitan System amounted to $468,169.21.

The following is a detailed financial statement regarding the Metropolitan Sewerage Works: —

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, the expenditures for construction, and the balance available on January 1, 1912, have been as follows: —

(*a*) *North Metropolitan System.*

Loans authorized under various acts prior to 1911 for the construction of the North Metropolitan System and the various extensions,	$6,573,865 73	
Loan authorized under chapter 512 of the Acts of 1911, for the Malden and Everett extension, ...	62,000 00	
		$6,635,865 73

Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System: —			
For the year ending December 31, 1911,		$1,168 86	
For the period prior to January 1, 1911,		63,391 78	
			64,560 64
			$6,700,426 37
Amount approved for payment by the Board[1] out of the Metropolitan Sewerage Loan Fund, North System: —			
For the year ending December 31, 1911,		$165,695 35	
For the period prior to January 1, 1911,		6,521,196 15	
			6,686,891 50
Balance, North Metropolitan System, January 1, 1912,			$13,534 87

(b) *South Metropolitan System.*

Loans authorized under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension constituting the South Metropolitan System,			$8,867,046 27
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —			
For the year ending December 31, 1911,		$231 38	
For the period prior to January 1, 1911,		13,401 13	
			13,632 51
			$8,880,678 78
Amount approved by the Board[1] for payment out of the Metropolitan Sewerage Loan Fund, South System: —			
On account of the Charles River valley sewer,		$800,046 27	
On account of the Neponset valley sewer,		911,531 46	
On account of the High-level sewer and extension: —			
For the year ending December 31, 1911,	$20,452 89		
For the period prior to January 1, 1911,	7,081,201 91		
		7,101,654 80	
			8,813,232 53
Balance, South Metropolitan System, January 1, 1912,			$67,446 25

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[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

(2) ISSUES OF METROPOLITAN SEWERAGE LOAN BONDS.

The Treasurer of the Commonwealth, under the authority of the successive statutes, has from time to time issued bonds designated "Metropolitan Sewerage Loan," amounting for the North System to $6,625,000 and for the South System to $8,877,912. The list of the bonds issued prior to the year 1910 is contained in the Ninth Annual Report. The bonds issued in the year 1911 are as follows: —

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
July 20, 1911, ...	$62,000	3½	100.00[1]	Jan., 1941	-

[1] Not issued or delivered until 1912.

(3) METROPOLITAN SEWERAGE LOANS SINKING FUND.

Under the authority of chapter 122 of the Acts of the year 1899 the Treasurer and Receiver-General of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan Sewerage Loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund.

The Board received during the year, from rentals and from other sources, to be applied to the sinking fund, $259.20.

The sinking fund established has amounted at the end of each year to sums as follows: —

December 31, 1899, .	$361,416 59
December 31, 1900, .	454,520 57
December 31, 1901, .	545,668 26
December 31, 1902, .	636,084 04
December 31, 1903, .	754,690 41
December 31, 1904, .	878,557 12
December 31, 1905, .	1,008,724 95
December 31, 1906, .	$1,146,998 68
December 31, 1907, .	1,306,850 30
December 31, 1908, .	1,492,418 98
December 31, 1909, .	1,673,784 40
December 31, 1910, .	1,931,741 89
December 31, 1911, .	2,184,674 98

(4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1911, have been as follows: —

North Metropolitan System.

Appropriation under chapter 691 of the Acts of 1911,	$152,800 00
Balance of appropriation under chapter 582 of the Acts of 1908,	849 43
Receipts from pumping and from other sources,	357 43
	$154,006 86
Amount approved by the Board for payment,	149,163 19
Balance, January 1, 1912,	$4,843 67

South Metropolitan System.

Appropriation under chapter 687 of the Acts of 1911,	$101,800 00
Receipts from pumping and from other sources,	378 46
	$102,178 46
Amount approved by the Board for payment,	100,399 39
Balance, January 1, 1912,	$1,779 07

(5) ANNUAL ASSESSMENTS.

Assessments for the year, amounting to $463,311.33 for the North Metropolitan System and to $468,169.21 for the South Metropolitan System, were required for the payment of interest and sinking fund requirements and the cost of maintenance and operation of works. The requirements for the North Metropolitan System were: for interest, $202,078.43; for the sinking fund, $111,095.21; and for maintenance, $150,137.69. For the South Metropolitan System the requirements were: for interest, $299,330.62; for the sinking fund, $67,997.19; and for maintenance, $100,841.40. The assessments for both the North and South Metropolitan Systems were made upon the cities and towns in the District in accordance with chapter 369 of the Acts of the year 1906. The respective assessments were as follows: —

North Metropolitan Sewerage System.

Arlington,	$10,948 34	Revere,	$15,308 99
Belmont,	6,007 21	Somerville,	64,250 86
Boston,	77,610 33	Stoneham,	5,346 50
Cambridge,	103,511 80	Wakefield,	9,505 15
Chelsea,	25,718 84	Winchester,	11,566 58
Everett,	27,209 17	Winthrop,	10,773 33
Lexington,	4,210 15	Woburn,	11,883 88
Malden,	41,700 23		
Medford,	22,263 45	Total,	$463,311 33
Melrose,	15,496 52		

South Metropolitan Sewerage System.

Boston,	$202,379 19	Quincy,	$29,264 37
Brookline,	84,798 49	Waltham,	26,560 46
Dedham,	11,571 71	Watertown,	13,749 10
Hyde Park,	14,211 55		
Milton,	21,757 47	Total,	$468,169 21
Newton,	63,876 87		

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.	
North Metropolitan System.			
Original system, main line and branches,	-		$5,383,957 67
Lexington branch,	-		68,585 15
Everett branch,	-		54,877 12
Wakefield branch,	-		35,698 29
Stoneham branch,	-		11,574 10
Revere extension,	-		215,722 79
Chelsea and Everett outlets,	-		71,216 41
Wakefield branch extension,	-		190,081 97
Belmont extension,	-		57,363 06
Malden extension,	-		67,092 63
Bulkhead, Chelsea creek,	-		3,231 00
North System, enlargement: —			
Administration,	$4,300 28	$13,218 05	
Deer Island pumping station, extensions and additions,	19,625 38	195,373 14	
Amounts carried forward,	$23,925 66	$208,591 19	$6,159,400 19

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$23,925 66		$208,591 19	$6,159,400 19
North Metropolitan System — Con.				
North System, enlargement — *Con.*				
East Boston pumping station, extensions and additions,	78,913 36		242,438 27	
Malden-Everett extension, Sections 65 and 66,	57,138 50		57,770 70	
Stable and locker, East Boston,	5,717 83		18,691 15	
		$165,695 35		527,491 31
Total for North Metropolitan System,		$165,695 35		$6,686,891 50
South Metropolitan System.				
Charles River valley sewer, main line,	-			$800,046 27
Neponset River valley sewer: —				
Main line,	-		$866,595 66	
Brookline branch,	-		44,935 80	
				911,531 46
High-level Sewer,		$285 00		5,992,660 01
High-level Sewer extension: —				
Charles River valley studies,	-		$3,893 71	
Administration,	$1,391 67		16,455 81	
Section 80, day work, West Roxbury and Brookline,	242 50		295,216 41	
Section 81, Brookline,	155 00		129,519 35	
Section 82, Brookline,	-		136,152 02	
Section 82, day work, Park street crossing,	-		2,030 18	
Section 83, Brookline,	247 00		94,065 87	
Section 84, Brookline and Brighton,	-		47,592 89	
Section 85, Brighton,	3 00		227,378 50	
Section 85, day work, Brighton,	-		66,611 62	
Section 86, Brighton,	675 00		57,864 88	
Quincy sewage lifting station,	17,403 72		24,044 60	
Land takings, purchase and recording,	50 00		8,168 95	
		20,167 89		1,108,994 79
Total for South Metropolitan System,		$20,452 89		$8,813,232 53
Total for construction for both systems,		$186,148 24		$15,500,124 03

MAINTENANCE.	For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.
North Metropolitan System,	$149,163 19	$1,885,736 29
South Metropolitan System,	100,399 39	1,511,466 37
Total for maintenance, both systems,	$249,562 58	$3,397,202 66

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1911: —

(a) *Expenditures and Disbursements.*

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.		
North Metropolitan System.		
Administration: —		
Commissioners,	$1,166 67	
Secretary,	750 00	
Clerks and stenographers,	1,551 01	
Traveling,	-	
Stationery, printing and office supplies,	505 23	
Telephone, lighting, heating, water and care of building,	162 11	
Rent and taxes, main office,	165 26	
Repairs of building,	-	
Miscellaneous expenses,	-	
		$4,300 28
Engineering: —		
Chief engineer,	$833 33	
Engineering assistants,	3,648 50	
Inspectors,	1,375 00	
Traveling expenses,	25 25	
Stationery, printing and office supplies,	20 89	
Engineering and drafting instruments and tools,	-	
Engineering and drafting supplies,	-	
Telephone, lighting, heating, water and care of building,	486 37	
Rent and taxes,	495 80	
Repairs of building,	-	
Miscellaneous expenses,	5 24	
		6,890 38
Advertising,	-	
Labor and teaming,	$12,818 79	
Tools, machinery and appliances,	7,016 64	
Brick, cement, lumber and other field supplies and expenses,	7,233 35	
		27,068 78
Contracts: —		
Allis-Chalmers Co., contract 68, addition to pumping plant at Deer Island pumping station,	$17,307 50	
Allis-Chalmers Co., contract 73, addition to pumping plant at East Boston pumping station,	33,300 00	
Amounts carried forward,	$50,607 50	$38,259 44

General Character of Expenditures.	For the Year ending December 31, 1911.	
Amounts brought forward,	$50,607 50	$38,259 44
North Metropolitan System — Con.		
Contracts — *Con.*		
The Philip Carey Co., contract 93, magnesia covering to boilers and piping at East Boston pumping station,	2,234 55	
Lumsden & Van Stone Co., contract 89, piping in East Boston pumping station,	5,400 00	
Robb-Mumford Boiler Co. (Robb Engineering Co., Ltd., assignee), contract 78, furnishing and erecting six vertical fire-tube boilers with smoke flue and galleries, at the East Boston pumping station,	6,386 60	
A. G. Tomasello, contract 81, constructing Section 66 of the North Metropolitan Sewerage System (Malden-Everett Extension),	17,553 74	
Woodbury & Leighton Co., contract 74, extension of engine, boiler, screen-house and coal-house at East Boston pumping station,	8,764 87[1]	
		90,947 26
Real estate: —		
Settlements,	$36,480 08	
Legal, conveyancing and expert,	8 57	
		36,488 65
Total for North Metropolitan System,	. . .	$165,695 35
South Metropolitan System.		
High-level Sewer.		
Engineering: —		
Engineers, inspectors, rodmen, laborers and others,	$285 00	
		$285 00
High-level Sewer Extension.		
Administration: —		
Commissioners,	$750 00	
Secretary,	-	
Clerks and stenographers,	396 67	
Traveling,	-	
Stationery, printing and office supplies,	127 01	
Telephone, lighting, heating, water and care of building,	61 65	
Rent and taxes, main office,	55 09	
Miscellaneous expenses,	1 25	
		1,391 67
Engineering: —		
Chief engineer,	-	
Engineering assistants,	$2,829 43	
Amounts carried forward,	$2,829 43	$1,676 67

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[1] Of this amount $15.57 was paid to the North Metropolitan Maintenance Fund, to balance an overpayment from said fund on account of special appropriation Chapter 582, Acts of 1908, there being but $849.43 to cover the final estimate amounting to $865 due Woodbury & Leighton under Contract 74A.

General Character of Expenditures.	For the Year ending December 31, 1911.	
Amounts brought forward,	$2,829 43	$1,676 67
South Metropolitan System — Con.		
Engineering — *Con.*		
Inspectors,	-	
Traveling expenses,	-	
Stationery, printing and office supplies,	2 29	
Engineering and drafting instruments and tools,	-	
Engineering and drafting supplies,	-	
Telephone, lighting, heating, water and care of building,	184 94	
Rent and taxes,	165 26	
Miscellaneous expenses,	-	
		3,181 92
Advertising,	-	
Labor and teaming,	$3,151 37	
Tools, machinery and appliances,	1,375 78	
Brick, cement, lumber and other field supplies and expenses,	2,736 19	
		7,263 34
Contracts: —		
John Cashman & Sons Co., contract 87, Quincy sewage lifting station, foundations,	$6,555 96	
C. A. Dodge Co., contract 88, Quincy sewage lifting station, superstructure,	1,725 00	
		8,280 96
Real estate: —		
Settlements,	-	
Legal, conveyancing and expert,	$50 00	
		50 00
Total for South Metropolitan System,		$20,452 89
MAINTENANCE AND OPERATION OF WORKS.		
North Metropolitan System.		
Administration: —		
Commissioners,	$2,749 99	
Secretary and assistants,	2,432 89	
Rent,	247 88	
Heating, lighting and care of building,	233 57	
Repairs of building,	19 02	
Postage,	41 00	
Printing, stationery and office supplies,	647 80	
Telephones,	60 14	
Traveling expenses,	37 69	
Miscellaneous expenses,	25 00	
		$6,494 98
General supervision: —		
Chief engineer and assistants,	$8,203 15	
Rent,	743 69	
Heating, lighting and care of building,	700 80	
Amounts carried forward,	$9,647 64	$6,494 98

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
Amounts brought forward,	$9,647 64	$6,494 98
North Metropolitan System — Con.		
General supervision — *Con.*		
Repairs of building,	56 98	
Postage,	60 00	
Printing, stationery and office supplies,	288 93	
Telephones,	180 44	
Traveling expenses,	145 00	
Miscellaneous expenses,	17 32	
		10,396 31
Deer Island pumping station: —		
Labor,	$15,745 75	
Fuel,	9,204 34	
Oil and waste,	657 60	
Water,	874 80	
Packing,	250 75	
Repairs and renewals,	466 84	
Telephones,	190 81	
General supplies,	847 04	
Miscellaneous supplies and expenses,	103 70	
		28,341 63
East Boston pumping station: —		
Labor,	$19,718 80	
Fuel,	13,378 03	
Oil and waste,	433 65	
Water,	1,215 60	
Packing,	117 93	
Repairs and renewals,	333 99	
Telephones,	119 34	
General supplies,	1,031 92	
Miscellaneous supplies and expenses,	666 81	
		37,016 07
Charlestown pumping station: —		
Labor,	$14,725 26	
Fuel,	3,259 39	
Oil and waste,	280 27	
Water,	847 20	
Packing,	70 30	
Repairs and renewals,	350 44	
Telephones,	46 49	
General supplies,	457 47	
Miscellaneous supplies and expenses,	123 19	
		20,160 01
Alewife Brook pumping station: —		
Labor,	$7,816 00	
Fuel,	1,291 68	
Oil and waste,	189 88	
Water,	295 80	
Amounts carried forward,	$9,593 36	$102,409 00

General Character of Expenditures.	For the Year ending December 31, 1911.	
Amounts brought forward,	$9,593 36	$102,409 00
North Metropolitan System — Con.		
Alewife Brook pumping station — *Con.*		
Packing,	15 11	
Repairs and renewals,	138 77	
Telephones,	40 94	
General supplies,	66 76	
Miscellaneous supplies and expenses,	195 44	
		10,050 38
Sewer lines, buildings and grounds: —		
Engineering assistants,	$2,650 00	
Labor,	24,346 99	
Automobiles,	211 21	
Brick, cement and lime,	484 41	
Castings, ironwork and metals,	326 06	
Freight, express and teaming,	1 40	
Fuel and lighting,	64 98	
Jobbing and repairing,	257 51	
Lumber,	107 86	
Machinery, tools and appliances,	656 16	
Paints and oils,	798 91	
Rubber and oiled goods,	342 08	
Sand, gravel and stone,	1 50	
Telephones,	13 85	
Traveling expenses,	342 81	
General supplies,	574 50	
Miscellaneous expenses,	124 69	
		31,304 92
Horses, vehicles and stable account,	$4,533 89	
Renewal East Boston pumping station account Chelsea fire, April 12, 1908: —		
Supplies and expenses,	865 00	
		5,398 89
Total for North Metropolitan System,		$149,163 19
South Metropolitan System.		
Administration: —		
Commissioners,	$2,333 34	
Secretary and assistants,	2,345 81	
Rent,	220 34	
Heating, lighting, and care of building,	206 58	
Repairs of building,	10 43	
Postage,	80 00	
Printing, stationery and office supplies,	525 19	
Telephones,	46 37	
Traveling expenses,	14 00	
Miscellaneous expenses,	26 00	
		$5,808 06
Amount carried forward,		$5,808 06

General Character of Expenditures.	For the Year ending December 31, 1911.	
Amount brought forward,	. . .	$5,808 06
South Metropolitan System — Con.		
General supervision: —		
Chief engineer and assistants,	$5,341 61	
Rent,	661 06	
Heating, lighting and care of building,	619 78	
Repairs of building,	31 29	
Postage,	-	
Printing, stationery and office supplies,	210 19	
Telephones,	139 13	
Traveling expenses,	159 00	
Miscellaneous expenses,	1 00	
		7,163 06
Ward Street pumping station: —		
Labor,	$19,139 74	
Fuel,	7,466 23	
Oil and waste,	309 25	
Water,	1,348 80	
Packing,	108 35	
Repairs and renewals,	820 70	
Telephones,	94 78	
General supplies,	976 34	
Miscellaneous supplies and expenses,	439 92	
		30,704 11
Quincy pumping station: —		
Labor,	$6,946 83	
Fuel,	1,620 85	
Oil and waste,	76 79	
Water,	339 73	
Packing,	11 86	
Repairs and renewals,	128 12	
Telephones,	36 06	
General supplies,	103 94	
Miscellaneous supplies and expenses,	233 61	
		9,497 79
Nut Island screen-house: —		
Labor,	$7,881 50	
Fuel,	2,424 25	
Oil and waste,	52 18	
Water,	356 76	
Packing,	19 10	
Repairs and renewals,	10 40	
Telephones,	55 74	
General supplies,	489 54	
Miscellaneous supplies and expenses,	71 68	
		11,361 15
Amount carried forward,	. . .	$64,534 17

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
Amount brought forward,	. . .	$64,534 17
South Metropolitan System — Con.		
Sewer lines, buildings and grounds: —		
Engineering assistants,	$2,650 00	
Labor,	19,749 38	
Automobiles,	437 64	
Brick, cement and lime,	440 38	
Castings, ironwork and metals,	131 65	
Freight, express and teaming,	–	
Fuel and lighting,	102 80	
Jobbing and repairing,	21 00	
Lumber,	340 84	
Machinery, tools and appliances,	127 77	
Paints and oils,	218 55	
Rubber and oiled goods,	74 62	
Sand, gravel and stone,	45 49	
Telephones,	35 40	
Traveling expenses,	615 68	
General supplies,	224 83	
Miscellaneous expenses,	24 27	
		25,240 30
City of Boston, for pumping and interest,	. . .	7,700 00
Horses, vehicles and stable account,	. . .	2,924 92
Total for South Metropolitan System,	. . .	$100,399 39

(*b*) *Receipts.*

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

ACCOUNT.	For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.
North Metropolitan System — construction,	$1,168 86	$64,560 64
South Metropolitan System — construction,	231 38	13,632 51
North Metropolitan System — maintenance,	357 43	14,998 66
South Metropolitan System — maintenance,	378 46	2,108 66
Metropolitan Sewerage Loans Sinking Fund,	259 20	1,802 59
Totals,	$2,395 33	$97,103 06

(c) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate connected therewith.

(d) *Liabilities.*

The sums due on monthly pay rolls amount to $650.72 and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
High-level Sewer: —		
National Contracting Co.,	Sect. 73, contract abandoned,	$5,516 17[1]
E. W. Everson & Co.,	Sect. 75, contract 14,	1,000 00
High-level Sewer Extension: —		
Timothy J. O'Connell,	Sect. 82, in part, contract 57,	60 00
Geo. M. Bryne Co.,	Sect. 85, in part, contract 63,	2,508 51
North Metropolitan Construction: —		
Allis-Chalmers Co.,	Addition to pumping plant at East Boston pumping station, contract 73,	3,700 00
A. G. Tomasello,	Sect. 66, Malden-Everett extension, contract 81,	2,969 95

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[1] Damages claimed by the Commonwealth on account of the abandonment of the contract exceed this amount.

Claims have been made by the following parties, but it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them: —

Anna L. Dunican, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Richard Jones, James Doherty, Michael Niland, William H. Gibbons, Francis Normile, George A. Goddard.

VIII. RAINFALL AND WATER SUPPLY.

The past year has added another to a remarkable series of years of small rainfall. The total rainfall during the year was about 38.5 inches, or about 7 inches below that of a long period of years in the past. Though there was a slight increase in the amount of rainfall over that of the preceding and two or three previous years, owing to the conditions under which the rain fell, a smaller quantity was gained for consumption. The amount of water collected from the various watersheds from which the water is drawn for the supply of the Metropolitan District was less than that recorded in any previous year in which measurements have been taken.

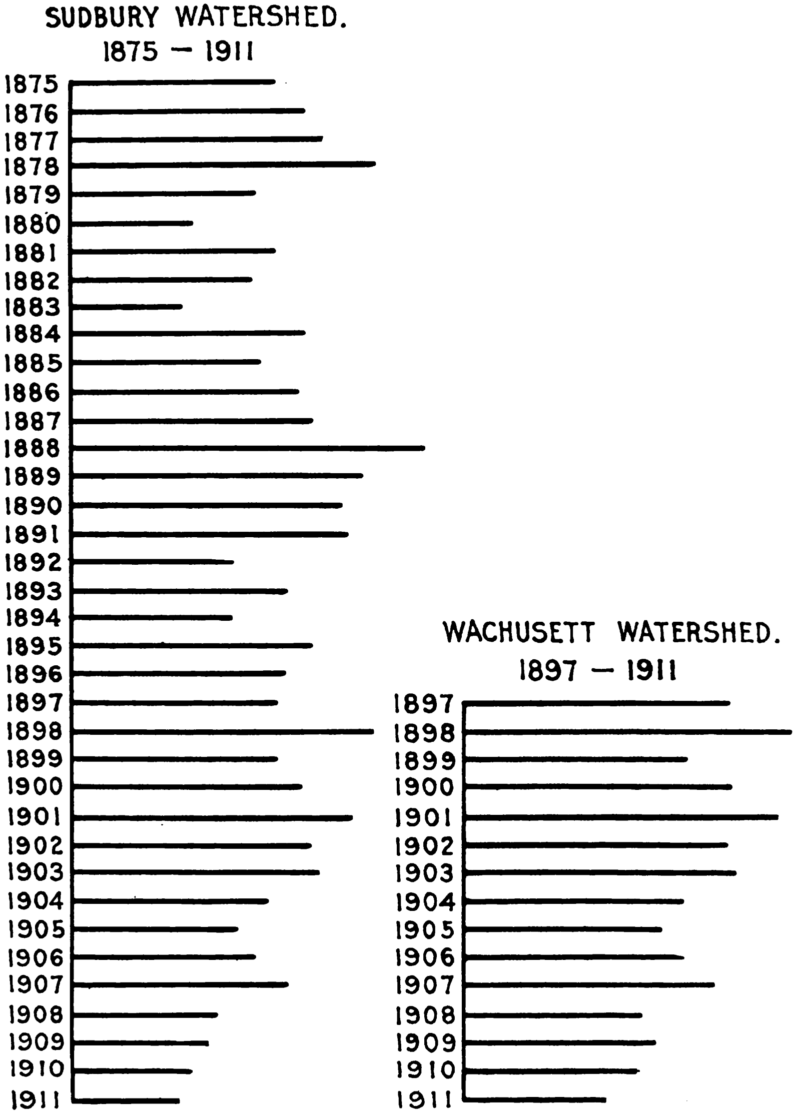
The Wachusett watershed yielded for consumption a daily average per square mile of 682,000 gallons, while the average for the 15 years during which the measurements have been made has been 1,107,000 gallons; and the Sudbury watershed yielded a daily average of 514,000 gallons per square mile as against a daily average of 1,013,000 gallons per square mile during the 37 years for which records have been kept. It is thus shown that the yield in the past year of the two watersheds was respectively 61.6 and 50.7 per cent. of the average amount yielded in the series of years.

The small quantity of water collected for the water supply during the year 1911 is indicated by the accompanying diagram in comparison with the larger quantity collected in each of the previous years. The diagram also illustrates the recurrence during the last four years of a dry period similar to, but still more severe than that of the four years ending with 1883, which has hitherto been looked upon as a period of minimum water supply unprecedented in the records.

IX. CONSUMPTION OF WATER.

For the third consecutive year there has been a reduction in the quantity of water required for the consumption of the Metropolitan District. The maximum quantity of water supplied to the District was reached in the year 1908, when the daily average consumption was 125,441,000 gallons, or 129 gallons for each person. The daily average consumption per capita fell in 1909 to 119 gallons, in 1910 to 110 gallons, and in the past year it was still farther reduced to 105 gallons, or a total consumption of 109,994,800 gallons per day. There is a slight difference between the quantities delivered to the various cities and towns, as measured by the Venturi meters, and the total quantity indicated as delivered to the District by the computation of the amount pumped at the several pumping stations and of the amount flowing in the Weston Aqueduct, on account of the small amount supplied to the stations and outside the

COMPARATIVE AMOUNTS OF WATER COLLECTED IN THE DIFFERENT YEARS ON THE SUDBURY AND WACHUSETT WATERSHEDS PER SQUARE MILE OF WATERSHED.



District and that lost by leakage from the distributing reservoirs and pipe mains.

In 11 of the municipalities there was a decrease in the daily per capita consumption. The largest decrease was in the city of Medford and in the town of Stoneham, where the reduction per capita was respectively 11 and 13. The city of Boston reduced its daily consumption from 130 to 124 gallons per person, and this reduction accounts chiefly for the gratifying decrease of the total consumption of the District.

There were 5 municipalities in which there was an increase in the per capita consumption, Belmont showing an increase of 12 gallons, Nahant of 7 gallons, Revere of 4 gallons, and Malden and Arlington of a single gallon each. Milton and Swampscott maintained the same rate as in the preceding year.

During the past year 14,099 water services, new and old, in the District were equipped with meters, and there was a substantial compliance with the Meter Act of the year 1907 both in the installation of meters on all new services and the equipment with meters of at least five per cent. of all the old services. The cities of Medford and Melrose and the towns of Watertown, Milton, Winthrop, Belmont and Swampscott have now meters upon all their services, and the cities of Malden and Chelsea have metered about 94 per cent. of all services. The city of Boston installed an increased number of meters during the past year, but its percentage of the number of its services metered (27.33) is still the lowest in the list. The cities of Quincy and Chelsea were especially active in the metering of old services.

The weather conditions of the past and the preceding year were similar and in general favorable to a low consumption of water, but the increasing introduction of meters must be considered as the principal factor in the reduction of consumption.

It is, however, apparent more than ever that there is a great waste of water in the Metropolitan District which the increasing use of meters does not prevent. Notwithstanding the large actual decrease in the total quantity of water which is supplied, the amount which is drawn from the pipes between the hours of 1 and 4 in the morning has not decreased; the amount thus drawn between these hours, when the necessary use is comparatively small, has been at the rate of more than 68 gallons per day for each inhabitant of the District. There is a constant leakage of water due to defective local pipes and bad house plumbing and to incessant flow from the faucets, by which water is wasted to the extent probably of one-third of the entire supply afforded.

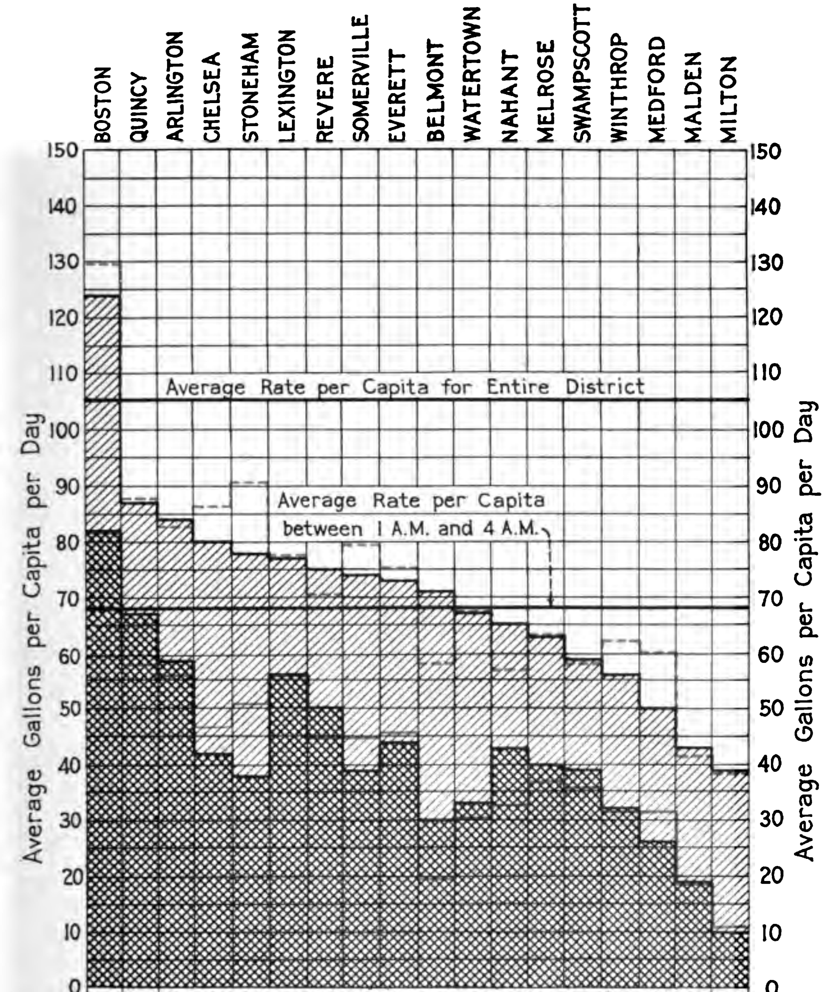
This situation demands more careful supervision on the part of the responsible authorities of the various cities and towns and the adoption of rigorous measures of prevention. Unless such means of checking the unnecessary and wasteful consumption shall be taken by the local authorities it would seem that the Legislature may be called upon to impose upon metropolitan agents the duty of exercising such supervision and inspection, not only in the interest of economy for the District and of delaying the time when additional sources of supply must be sought and new and extensive works be constructed, but also in behalf of the remote communities of the Commonwealth whose properties and rights will have to be yielded up for the benefit of the Metropolitan District. All reasons demand of the Metropolitan cities and towns the adoption of proper measures for the conservation of the present water supply and the limitation of the consumption of water to the legitimate and necessary requirements of their people.

The accompanying diagram, similar to that which has been given in past reports, showing the average rate of consumption in the past year during the entire day and between the hours of 1 and 4 in the morning, graphically illustrates the need of renewed attention to the subject of unnecessary and wasteful consumption, as well as the influence of the general use of meters prevailing in a portion of the cities and towns of the District.

In addition to the quantity of water which is supplied to the cities and towns of the Metropolitan District a total of 1,260,622,200 gallons, an equivalent of 3,453,700 gallons per day, have been drawn from the Metropolitan Water sources at various points for the benefit of places outside of the District, for which the sum of $11,820.29 has been received during the year.

In accordance with the provisions of the Legislature the city of Worcester has diverted from the Wachusett watershed a total of 759,800,000 gallons for its uses, and the town of Framingham, by like provisions, has drawn from Farm Pond and the Sudbury Aqueduct for its water supply 264,000,000 gallons, for which compensation is provided.

DIAGRAM SHOWING
AVERAGE RATE OF CONSUMPTION OF WATER IN THE METROPOLITAN DISTRICT IN 1911
DURING THE ENTIRE DAY
AND
BETWEEN THE HOURS OF 1 AND 4 AT NIGHT



Percentage of Services Metered 1910-1911

	BOSTON	QUINCY	ARLINGTON	CHELSEA	STONEHAM	LEXINGTON	REVERE	SOMERVILLE	EVERETT	BELMONT	WATERTOWN	NAHANT	MELROSE	SWAMPSCOTT	WINTHROP	MEDFORD	MALDEN	MILTON
Dec. 31, 1910	20.0	36.1	62.8	64.3	43.3	56.8	26.0	47.8	22.0	100.0	100.0	42.7	100.0	99.1	95.9	94.4	96.3	100.0
Dec. 31, 1911	27.3	62.0	70.4	94.3	55.4	69.7	34.9	53.2	28.5	100.0	100.0	50.8	100.0	100.0	100.0	100.0	95.8	100.0

Daily Average Rate of Consumption 1911........................ ▨

" " " Night " between 1 A.M. and 4 A.M. 1911 ▩

Daily Average Rate of Consumption in 1910 shown in Red.

Under permanent arrangements made with the Board, water to the amount of 53,053,000 gallons has been furnished for its main supply to the Westborough State Hospital from the open channel of the Wachusett Aqueduct; and, directly from the Metropolitan Works, 32,598,000 gallons have been furnished to the United States Government for its uses on Peddock's Island; and 4,782,500 gallons have been supplied to a portion of the town of Saugus which is connected with the water works of the town of Revere.

Under the recent statute authorizing the Board to furnish water to cities and towns outside of the District in cases of temporary emergencies, the town of Wakefield was in the latter part of the year supplied with a total of 83,948,700 gallons, and the city of Worcester with 62,440,000 gallons.

Although it does not in any degree afford a reason or excuse for neglecting any means which may be possible for conserving the supply for the future, it is gratifying that, notwithstanding the almost unprecedented small amount of rainfall following a series of dry years unknown to the past records, the Metropolitan District has during the past year been brought neither to inconvenience nor apprehension on account of the scarcity of water, and has been able to assist two other communities in the emergencies which they have suffered.

X. RECOMMENDATIONS FOR LEGISLATION.

In its preliminary report to the Legislature the Board has not asked for authority to construct any additional works for the Metropolitan Water System, and the loans already authorized are deemed sufficient for the completion of the works in progress. Neither has any construction been called for in the South Metropolitan Sewerage System.

The Board has, however, been compelled to ask for authority to proceed to supply new screening machinery for the East Boston pumping station and to construct a supplementary sewer in the Mystic valley, both of these works being in the North Metropolitan Sewerage System. The reasons for these requests are given in the preliminary annual report as follows: —

> The original plan for the improvement and extension of the East Boston pumping station contemplated new screening machinery. The amount esti-

mated as necessary for the purpose, however, was not included in the appropriation as made by the Legislature. Now that the other work has been completed the Board deems it advisable to remedy the defects existing in this machinery. The screens are now operated under ground in a deep pit, and their operation is not only difficult and unsanitary, but is expensive and uneconomical. The Board, therefore, has recommended that authority be given to acquire additional land and to provide new machinery for the purpose. The sum of $28,000 is estimated as the amount necessary to accomplish the improvement.

The Board finds itself compelled to call attention to the situation relative to the disposal of the sewage in the Mystic Valley and to recommend that measures be taken for the relief of the conditions which now prevail there.

The Metropolitan Sewerage Commission, as early as the year 1890, planned to dispose of the sewage and manufacturing wastes of the city of Woburn and the towns of Winchester and Stoneham by purchasing from the city of Boston the old Mystic Valley sewer, which had been originally constructed to protect the Mystic water supply, and by building in addition a new Metropolitan sewer. It was anticipated that the two sewers would be sufficient in the natural course of events to provide for this district for a long period of years. Since the date when this system was projected there has been a large and unanticipated increase in population in this region, due in part to more extended transit facilities, and there has also been a large growth in the tanning and other manufacturing establishments.

The quantity and character of the sewage and of other matters which are received in the Metropolitan sewers have been a subject of serious consideration for several years. The Board has caused the adoption of various measures for meeting the difficulties existing and for the purpose of postponing the time in which a supplementary sewer shall be required for the Mystic Valley. There has been a substantial compliance with the requirements of the Board that the tanneries and other manufacturing establishments should prevent, by settling tanks or otherwise, the entrance into the sewers of the objectionable wastes which not only increase the volume of matter received, but, being of a glutinous character, clog the sewers and decrease their carrying capacity. There are, however, very large quantities of liquids discharged into the sewers from these establishments, and a great increase in these quantities seems imminent in the near future on account of projected extensions of existing works and erection of new establishments. At the same time there is a large and steady increase in the population contributing sewage.

The old Mystic Valley sewer and the additional Metropolitan sewer, constructed by the Metropolitan Sewerage Commission have a combined maximum capacity at the point where the old Mystic sewer ends of about 14,000,000 gallons per day. This capacity has at times not only been reached but in certain periods of successive hours in the day has been greatly exceeded, having reached a maximum of discharge of about 17,300,000 gallons per day and in a few cases in the past there have been actual overflows from the manholes. There have been like overflows from the local sewers.

Very recent events have tended to hasten the Board to the conclusion that it should now advise entering upon the construction of a new supplementary sewer during the present year.

The town of Winchester has in the past year entered upon certain large improvements affecting the Aberjona River and the region through which the present sewers pass, which, if carried out, will seem to demand a change and improvement in the sewage disposal.

The Legislature of last year by chapter 291 authorized and directed the State Board of Health to prevent the entrance or discharge of sewage or any other substance, which might be injurious to the public health or might tend to create a public nuisance, into any part of the Aberjona River or its tributaries, and the statute further provides that whoever permits the entrance or discharge therein of any sewage or other such substance shall be punished by a fine not exceeding $500 for each offense.

It is the opinion of our engineers, notwithstanding the disposal of the objectionable factory wastes in tanks, which has been effected recently, that under present possible circumstances times may occur, as in the past, when it will be impossible to convey away all the sewage matter entering the two sewers and consequently to prevent overflows directly or indirectly into the Aberjona River.

To keep the sewers in the present condition so as to dispose of the sewage, as it has been accomplished, has required extraordinary inspection and constant cleaning and flushing and enforcement of regulations, involving an expense of nearly $10,000 a year, the larger part of which would not be required if a new sewer as projected be built.

It therefore seems to the Board that it cannot longer delay in asking for authority to begin the construction of a supplementary sewer during the coming year.

Such a new sewer as recommended by the engineers would extend from a point near the boundary line between the city of Woburn and the town of Winchester and after making connection with the Stoneham branch proceed through the congested district of Winchester and join the existing large Metropolitan main sewer in West Medford, whence this main has a safe carrying capacity for the whole district for many years to come. This new sewer as proposed would have a length of about 3.2 miles and a size varying from 3 feet to 4 feet in diameter, with a carrying capacity of about 22,000,000 gallons per day. The cost of its construction is estimated at $350,000.

The Board therefore recommends that the necessary authority be given for the issuance of bonds to the amount of $378,000 on account of the Metropolitan Sewerage Loan Fund, North System, in order to provide for supplying the screening machinery at the East Boston pumping station and for the construction of the supplementary sewer in the Mystic Valley.

XI. FUTURE WORK.

The Board has estimated that the maintenance and operation of the works for the water supply and its distribution to the cities and towns of the Metropolitan Water District will require for the current year the sum of $426,000, and of the works for the collection of sewage in the Metropolitan Sewerage Districts and its disposal will require an expenditure of $268,050, a total estimated expenditure for the current year of $694,050. Although this total estimated as necessary to be expended is about $20,000 greater than that of last year, largely by reason of the acts of the Legislature amending the eight-hour law and establishing $2.25 a day as the minimum wage of laborers, the total which will be required to be assessed upon the District will, it is anticipated, be less than that called for last year, on account of the income arising from the operation of the Wachusett power plant.

The estimates of the amount required include a request for the sum of $20,000, which may be expended by the Board from time to time for the protection and improvement of the water supply, as new menaces to the purity of the water upon the different watersheds appear, or as the sources of danger become more threatening.

There remains to be completed, as already authorized, a portion of the 60-inch main pipe line which is to constitute a second main for bringing the supply of water from the terminus of the Weston Aqueduct to the Chestnut Hill Reservoir, the part to extend from the Charles River to Valentine Street in Newton, a distance of about 14,400 feet, not yet having been constructed. It is anticipated that the portion of the line completed will relieve the pressing immediate needs and that it will not be necessary to enter upon the construction of the remainder of the line during the coming season.

The extension of the main pipe line from Forest Hills to the central portion of Hyde Park in order to furnish a water supply to that district, which has now become a part of the city of Boston, has been nearly completed. A new pumping station which is necessary in order to supply water to that section with the pressure which is ultimately desired has been begun and will be erected in the coming season. Two new pumping engines will be installed in the station.

While the construction of no large water works is called for in the coming year, considerable engineering labor will be necessary in order to bring to entire completion, with the necessary record plans, the works which have been recently finished or are near completion.

The Board has been called upon to make investigations and furnish information relative to supplying water to municipalities not now included in the Metropolitan Water District, and it does not seem improbable that, owing to the scarcity of the water supply in several cities and towns during the past year, the Board will be called upon by the Legislature at the present session to construct works in order, to furnish a water supply to some other municipalities not now included in the Metropolitan Water District.

The Board has made in its preliminary report to the Legislature recommendations for construction which, if adopted, will require extensive work upon the North Sewerage System, these being the provision of new screening machinery in connection with the improvements at the East Boston pumping station, and the building of an additional main sewer in the Mystic valley.

The Board has still under consideration the adequacy of the present works properly to dispose of the large amount of sewage which is discharged into the harbor from the Deer Island outlet, and it is probable that some measures will be called for in the early future in order to provide a better and more effective method by which the sewage shall be disposed of when discharged into the sea.

The detailed reports of the Chief Engineer of the Water Works and of the Chief Engineer of the Sewerage Works, with various tables and statistics are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE,
HENRY P. WALCOTT,
JAMES A. BAILEY, Jr.,
Metropolitan Water and Sewerage Board.

Boston, February 26, 1912.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following is a report of the work done under the charge of the Chief Engineer of the Metropolitan Water Works for the year ending December 31, 1911.

GENERAL STATEMENT.

The Chief Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for supplying water to the eighteen municipalities which have received their supply from the Metropolitan Works.

ORGANIZATION.

The Chief Engineer has had the following assistants: —

William E. Foss,	*Assistant to Chief Engineer.*
Elliot R. B. Allardice,	*Superintendent, Wachusett Department.*
Charles E. Haberstroh,	*Superintendent, Sudbury Department.*
Samuel E. Killam,	*Superintendent, Pipe Lines and Reservoirs, Distribution Department.*
Arthur E. O'Neil,	*Superintendent, Pumping Stations, Distribution Department.*
Alfred A. Doane,	*Division Engineer, specially in charge of engineering work at pumping stations.*
Barzillai A. Rich,	*Assistant Engineer, employed until December 20, 1911.*
Clifford Foss,	*Assistant Engineer.*
Benjamin F. Hancox,	*Assistant in charge of Drafting Department.*
James W. Killam,	*Assistant Engineer, in charge of tests of coal and oil.*
William E. Whittaker,	*Office Assistant.*
Arthur W. Walker,	*Biologist.*
William W. Locke,	*Sanitary Inspector.*

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 51, and at the end of the year, 46. The average force was constituted as follows: —

Chief Engineer,	1
Department Superintendents,	4
Division Engineers,	2
Assistant Engineers,	7
Assistant Engineer and Sanitary Inspector,	1
Draftsmen,	3
Instrumentmen,	7
Rodmen,	6
Inspectors,	2
Office Assistant,	1
Biologists,	2
Sanitary Inspectors,	2
Stenographers,	4
Clerks,	5
Photographer,	1
Messengers,	2
	50

There has also been a maintenance force, exclusive of the engineers above mentioned, averaging 225, employed in the operation of the several pumping stations and in connection with the maintenance of the reservoirs, aqueducts and pipe lines, and in doing minor construction work.

The number of men employed in the maintenance force of the several departments has been as follows: —

	Beginning of Year.	End of Year.	Average.
Wachusett Department,	39	47	47
Sudbury Department,	56	44	51
Distribution Department, pipe lines and reservoirs,	91	68	71
Distribution Department, pumping service,	58	60	56
	244	219	225

In addition to the men employed directly by the Board, a force averaging 79 men, reaching a maximum of slightly less than 200 in September, was employed from March 20 to December 15 by the contractors engaged in constructing new works.

CONSTRUCTION.

60-Inch Supply Main from the Weston Aqueduct.

This work was authorized by the Legislature in 1909, and a contract for furnishing 8,000 tons of 60-inch pipes was made in that year. Contracts for laying the pipes, for the construction of a concrete-lined rock tunnel, and for 363 feet of cement-lined steel pipe were made in 1910. Two of the contracts, covering the laying of 16,920 feet of 60-inch pipe, were completed in that year. During the past year the contract with Joseph Hanreddy for building the tunnel and laying the steel and cast-iron pipes at both ends connecting with the 60-inch cast-iron pipes laid in 1910, has been completed, and the main was placed in service on November 4, 1911. At the end of the year 1910, Mr. Hanreddy had practically finished the excavation of the tunnel, 2,040 feet long, and had laid 664 feet of 60-inch cast-iron pipe. The work remaining to be done consisted of lining the tunnel and laying and lining the cement-lined steel pipe. Active operations were resumed during the latter part of March in cleaning and trimming the tunnel preparatory to placing the concrete lining. On April 14 the placing of concrete in the bottom of the tunnel was begun, with a force of 22 men and 2 mules. The method employed in lining the tunnel was as follows: The bottom of the tunnel was first covered with concrete to an elevation 9 inches below the elevation of the finished invert. Steel forms of the Blaw collapsible type were then set up and the side walls and top of the tunnel were formed, after which the forms were removed and the invert cleaned and filled to the finished grade. Each of these operations was begun near the centre of the tunnel and carried on toward each portal. The concrete lining, with the exception of grouting, was completed from Station 18 to the west portal on June 15, and to the east portal on August 11. In order that all voids between the concrete lining and the rock should be thoroughly filled, and for the further purpose of preventing leakage from the tunnel when subject to an internal pressure of 20 pounds per square inch, 1½ inch wrought-iron pipes were built into the lining of the tunnel, extending into the spaces above the lining which could not be thoroughly filled by hand labor. Through these pipes, which were spaced irregularly but an average of 17 feet apart for the whole length of the tunnel, there was forced 292 cubic yards of Portland cement grout under a pressure of 60 pounds per square inch. The grout was composed of equal parts of Portland cement and finely screened sand mixed dry, to which sufficient water was added to obtain a mixture which would flow freely through the interstices in the concrete and seams in the rock. The grouting was begun on September 21 and completed on October 3. Between October 19 and 23, the interior of the tunnel was scraped and coated with a wash of Portland cement.

Between Station 4 + 36 and Station 6 + 38 and between Station 26 + 73 and Station 28 + 34 riveted steel pipes 80 inches in diameter, lined with cement mortar and covered on the outside with concrete, were used to form the connection between the concrete-lined rock tunnel and the 60-inch cast-iron pipes. The steel pipes were furnished in sections about 20 feet long by the Hodge Boiler Works of East Boston, and were placed, riveted together, lined and covered by the contractor for building the tunnel. Each 20-foot section of the pipe was made of three alternately large and small courses, each course being formed of a single sheet of flange steel 6 feet, 11 inches wide and 5/16 of an inch in thickness. The longitudinal joints were lapped 4⅜ inches and double-riveted with ¾-inch rivets spaced 2⅞ inches from centre to centre. The circular joints were lapped 2½ inches and single-riveted with ¾-inch rivets spaced about 2⅛ inches on centres. At intervals of about 40 inches, pads 6 inches in diameter and ½ inch in thickness were riveted on top of the pipe, through each of which was drilled and tapped a hole for a 2-inch diameter steel plug.

The placing and riveting together of the 20-foot sections of steel pipe at the west portal of the tunnel was begun on July 10 and finished on July 22. At the east portal this part of the work was begun on August 21 and completed on September 12. After the steel pipes were riveted and calked, they were thoroughly cleaned both inside and out by the sand-blast process, and immediately afterward covered with a wash of Portland cement applied with a brush. The work of covering the exterior of the steel pipes at the west portal of the tunnel with Portland cement concrete was begun on July 27 and finished on August 11. At the east portal this work was done between September 18 and 28. The concrete surrounding the pipes is 9 feet 8 inches wide on the bottom and 6 inches in thickness over the top of the pipes. The lining of the pipes was done at the west portal of the tunnel between August 19 and September 15, and at the east portal of the tunnel between September 27 and October 13.

The pipes are lined with Portland cement mortar composed of one part of cement and two parts of sand. These materials were mixed with water in barrels which were supported on a platform placed about 4 feet above the pipes. Blaw collapsible steel forms were set up inside the pipes, leaving a space of 2 inches between the outside of the forms and the inside of the pipes, and the thoroughly mixed material was run into these spaces through 2-inch pipes inserted in the holes made in the top of the 80-inch pipes. The lining was applied in lengths of 14 feet. At the junctions between the 76-inch mortar-lined steel pipes and the 60-inch cast-iron pipes, 76-inch × 60-inch cast-iron branches were set and the 60-inch outlet capped, for use when an additional main shall be required. The work of refilling and surfacing the trenches at the tunnel portals, removing the contractor's plant, replacing fences, etc., was completed on November 25.

At the end of the year there remained about 2,800 cubic yards of broken stone, suitable for concrete, and 1,500 cubic yards of stone dust, suitable for surfacing sidewalks and roadways.

The cost of the work done by Joseph Hanreddy under his contract was $114,472.13.

The maintenance force in July made the connection at Valentine Street in Newton between the 60-inch main laid by Cavanagh Brothers in 1910 and the 48-inch Metropolitan main laid in 1902. The cost of connecting the 48-inch pipe, setting the branch, laying the connecting pipes, setting a 36-inch valve, and doing all incidental work, was $1,421.64.

A leak due to a cracked pipe was discovered a short distance west of Walnut Street when the pipe line was being tested. The substitution of a perfect pipe cost $289.23.

The leakage from this main, as determined by meter measurement before the main was placed in service, was 6 gallons per minute for 16,928 feet of 60-inch main, and 19 gallons per minute for 2,035 feet of concrete tunnel and 363 feet of 76-inch cement-lined steel pipe.

The cost of all work in connection with the new main from a point near Valentine Street to the connection on Beacon Street near Chestnut Hill Avenue, a distance of 20,252 feet, to December 31, 1911, was $455,090.25, as follows: —

17,854 Feet of 60-inch Cast-iron Pipe.

Pipes, special castings and valves,	$215,198 10
Venturi Meter,	2,350 00
Laying pipes, including pipe-laying materials and earth excavation,	66,086 35
Rock excavation,	13,327 66
Valve chambers and concrete backing for curves,	2,820 65
Work in connection with changes in underground structures,	6,849 74
Resurfacing trench in Commonwealth Avenue, Newton, labor by city of Newton,	4,357 16
Making connections, testing and putting lines in operation,	10,703 48
Real Estate,	290 40
Engineering,	16,380 00
Total,	$338,363 54

Cost per foot, $18.95.

363 Feet of 80-inch Steel Pipe.

Steel pipe,	$3,725 57
Laying steel pipe, lining with mortar and covering with concrete,	6,113 69
Earth excavation,	4,138 01
Rock excavation,	2,538 25
Engineering,	383 00
Total,	$17,353 52

Cost per foot, $47.81.

2,042.5 Feet of 76-inch Pressure Tunnel in Rock.

Tunnel excavation,	$51,074 40
Crushing stone,	7,334 25
Concrete tunnel lining,	31,568 81
Grouting tunnel,	3,696 50
Extra work on shafts at old Cochituate Aqueduct tunnel, and miscellaneous,	800 00
Legal conveyancing and expert,	100 55
Engineering,	4,798 68
Total,	$99,373 19

Cost per foot, $48.65.

NEW SUPPLY MAIN TO EAST BOSTON.

The construction of an additional main for the supply of East Boston was begun in 1910, and the work was quite fully described in the report for that year. At the beginning of 1911 the work remaining to be done was the completion of the laying of the 36-inch pipes in the tunnel under Chelsea Creek, and of connecting the pipes in the tunnel with the pipe lines in East Boston and Chelsea, also the filling of the tunnel and shafts with Portland cement concrete and constructing chambers on top of the shafts. This work was completed on January 28, and the main was placed in service on February 17.

The tunnel was built and the pipes were placed in the tunnel by day labor, under the supervision of Charles A. Haskin. The work of laying the pipes connecting the pipes in the tunnel with the mains of the City of Boston in East Boston and with the pipes laid by contract in Chelsea, including the work of setting a Venturi meter and the making of the joints in the pipes through the tunnel, was done by the maintenance force.

A test of the portion of the pipe line laid in Chelsea streets, comprising 725 feet of 30-inch pipe and 2,876 feet of 36-inch pipe, showed a leakage of 2 gallons per minute, and a test of the portion, 812 feet in length, including the tunnel, showed a leakage of 3.2 gallons per minute.

The cost of the whole work was $91,960.49, as follows: —

729 Feet of 30-inch and 3,214 Feet of 36-inch Cast-iron Pipe in Public Streets.

Pipes and special castings,	$23,150 04
Laying pipes, including pipe-laying materials and earth excavation,	6,830 90
Pile driving and timber foundation,	3,533 08
Valve chambers and concrete backing for curves,	579 00
Work in connection with changes in underground structures,	2,357 71
Making connections, testing and preparing lines for service,	3,655 88
Engineering and preliminary,	2,293 26
Total,	$42,399 87

Cost per foot, $10.75.

504 Feet of 36-inch Cast-iron Pipe in Tunnel under Chelsea Creek.

Pipes and special castings,	$4,386 15
Tunnel excavation,	20,400 73
Brick lining,	10,544 36
Laying 36-inch pipe in tunnel,	4,054 72
Concrete protection for pipes in tunnel,	5,737 13
Testing line and miscellaneous expenses,	873 65
Legal, conveyancing and expert,	42 80
Real estate,	900 00
Engineering,	2,621 08
Total,	$49,560 62

Cost per foot, $98.33.

PUMPING ENGINE FOR SOUTHERN HIGH SERVICE.

The 40,000,000-gallon triple expansion crank and fly-wheel engine for which a contract was made in 1909 with the Holly Manufacturing Company, was first operated on March 27. This engine was operated 4,174 hours and 32 minutes during the year, equivalent to 173 days, 22 hours and 32 minutes, but the official duty trial has not as yet been made.

Two boilers for supplying steam to this engine have been furnished by the Robb-Mumford Boiler Company of South Framingham. One of these was delivered late in December, 1910, and the other on January 2, 1911. They were unloaded from the cars and placed in position in the boiler-room by F. Knight & Son, Corporation, for the sum of $600.

The steam pipes forming the connections with the existing pipes in the boiler-room were furnished by The Lumsden & Van Stone Company, for the sum of $447; and the Chapman Valve Manufacturing Company furnished eight 5-inch, one 6-inch and one 8-inch valve for $362.98. The covering of the boilers, steam pipe and smoke flues with magnesia plastic covering was done by the Philip Carey Company, for $739. Railings and galleries for use in the boiler-room and the bridge connecting Engines Nos. 7 and 12 were furnished by The Lumsden & Van Stone Company for $553.48.

The erection of steam piping, boiler flues and fittings, and of the galleries and railings in both boiler and engine-rooms was done by the regular employés at the station. The work of connecting the discharge pipes from the engine with the 36-inch and 30-inch mains in front of the pumping station, consisting of about 100 feet of 36-inch pipe and two 36-inch hydraulic valves, together with the covering of the hydraulic valve chamber and the construction of six brick chambers over valves outside the building, was done by the maintenance force at a cost for materials and labor of $5,570.07.

The cost of all the work connected with the installation of these engines, including the connecting pipes in the vicinity of the pumping station, to Dec. 31, 1911, was $132,397.36, as follows: —

	Pumping Engine.	
Engine No. 12,	$85,000 00	
Hydraulic valves, pipes and special castings,	3,515 54	
Labor and supplies for engine foundation and miscellaneous work,	9,223 31	
Total,		$97,738 85
	Boilers.	
Boilers Nos. 15 and 16,	$10,448 00	
Fuel economizer,	1,740 00	
Hauling and erecting boilers,	600 00	
Smoke flue,	536 00	
Grates,	437 75	
Non-conducting covering for boilers, steam pipes and flues,	739 00	
Steam pipes,	447 00	
Railings and galleries,	553 48	
Valves and special castings,	366 25	
Labor and supplies for boiler foundations and miscellaneous work,	3,138 38	
Total,		19,005 86
	Engineering.	
Engine No. 12 and Boilers Nos. 15 and 16,		4,743 21
Total for machinery,		$121,487 92
	Connecting Pumping Engine to Existing Pipe Lines.	
Pipes, special castings and valves,	$5,924 45	
Labor and supplies for pipe laying, and miscellaneous work,	3,938 16	
Engineering,	1,046 83	
Total,		$10,909 44

Extension of Works to Hyde Park.

On March 28, 1911, the town of Hyde Park applied to the Board for a supply of water from the Metropolitan Works. On May 18, 1911, an act of the Legislature was approved authorizing the expenditure of $212,000 for the construction of the necessary extension of the works. The amount appropriated is expected to cover the cost of the 24-inch main 10,200 feet long, extending from Morton Street at Forest Hills through Hyde Park Avenue to the Hyde Park line; a pumping station located at the end of the 24-inch main, containing two engines, each of 3,000,000 gallons capacity in 24 hours; a 20-inch main 6,700 feet long, extending from the pumping station through Hyde Park Avenue to Cleary Square, where it connects with existing mains in Hyde Park. The appropriation also covers the cost of a 20-inch main about 3,000 feet long from the pumping station to a connection with the pipes of the city of Boston at the junction of Poplar and Beech streets in West Roxbury. Through this pipe water is to be pumped to the standpipe on Bellevue Hill for the supply of the highest portions of West Roxbury, Hyde Park and Milton.

A contract for furnishing 2,561 tons of pipes and 71 tons of special castings for the work was made with the United States Cast Iron Pipe & Foundry Company on May 24, 1911. A storage yard was leased at Hyde Park from the New York, New Haven & Hartford Railroad, and fitted with a derrick for handling the pipes. The pipes began to arrive in the latter part of April.

The work of laying pipes for the Hyde Park extension has been done under three contracts.

Contract No. 341 for Section 39 was awarded to Michele Russo & Son on June 24. This contract included the laying of 10,086 feet of 24-inch pipe from Morton Street in Forest Hills Square through Washington Street, Walkhill Street and Hyde Park Avenue to the Hyde Park line. The work was begun June 28. Pipe laying was completed on November 30, and the work of refilling and resurfacing the trenches on December 12. At Station 47, where the pipe line is carried over the channel of Stony Brook, 36 feet of riveted steel pipe were used in place of cast iron pipe; and at the crossing over the new channel which is being constructed for Stony Brook in Walkhill Street, a temporary line of 24-inch cast-iron pipe about 100 feet in length was laid.

The maintenance force of the department laid the steel pipe and constructed a box at the Stony Brook crossing, laid the temporary line over the new channel of Stony Brook, laid 20 wooden insulating joints, set seven 1½-inch air valves and tested the work.

The test showed a leakage of 7 gallons per minute.

Contract No. 343, for Section 40, included the laying of 6,731 feet of 20-inch main from the terminus of the 24-inch main at a point near the Hyde Park line, through Hyde Park Avenue to Cleary Square in Hyde Park. This contract was awarded to James L. Bryne, of Dorchester, on July 12. Trench excavation was begun July 21 and the contractor finished the work on November 11, including the laying of 259.6 feet of 24-inch, 324.5 feet of 20-inch pipe and 121.5 feet of 6-inch and 12-inch pipe not included in the original contract.

The maintenance force made 15 insulating joints of wood, set four 1½-inch air valves and made the connection between the 20-inch main and the 12-inch Metropolitan extra high service main in Metropolitan Avenue. The test of this main showed a leakage of 2.3 gallons per minute.

Section 41 included a 20-inch pipe line from the pumping station on Hyde Park Avenue, crossing the New York, New Haven & Hartford Railroad, thence through Grew Avenue, Mansur, Burleigh, Dale and Poplar streets to Beech Street, a distance of 2,984 feet. Contract No. 344, for laying this pipe, was made with Andrew M. Cusack, of Boston, on August 28, who began work on August 29, and completed his contract on November 21. At the crossing of the New York, New Haven & Hartford Railroad eleven lengths of flexible ball and socket joint pipes were used in place of pipes with the ordinary leaded joint, for the purpose of preventing leaks at the joints, due to jar from the trains.

The maintenance force made the connections with the pipes of the city of Boston at the junction of Beech and Poplar streets, set two 1½-inch air valves and did considerable work in building an embankment over a portion of the pipe line in Mansur Street and Grew Avenue. The test of this line showed a leakage of 5 gallons per minute.

Land having an area of 61,928 square feet, lying between Hyde Park Avenue and the New York, New Haven & Hartford Railroad has been acquired, plans for a pumping station have been so far perfected that the coal pocket and engine and boiler house foundations are now under construction, and a contract has been made for making and installing two pumping engines. Plans and specifications for the pumping station superstructure and for the boilers are being made, and it is expected that the plant will be completed in readiness for operation before the first of December, 1912.

The work of excavating for the building foundations, grading the grounds, and for a side track which is to be constructed by the Railroad Company, was begun on October 18 by a day-labor force under the supervision of the engineering department. The work done by this force to the end of the year included 4,006 cubic yards of excavation, 339 cubic yards of concrete masonry in building foundations, and the laying of cast-iron and Akron pipe for sewers and drains.

A contract made on Sept. 18, 1911, calls for the construction and erection in readiness for use on or before Sept. 18, 1912, of two horizontal duplex compound engines, each having a capacity of 3,000,000 gallons in 24 hours. The contract price for the two engines is $16,600.

Although the pumping station will not be completed for nearly a year, the mains connecting the Metropolitan Works with the distribution system of Hyde Park are in readiness for use.

The cost of work in connection with the extension of the supply to Hyde Park to Dec. 31, 1911, was $112,584.36, as follows: —

134.4 Feet of 20-inch and 10,468.1 Feet of 24-inch Cast-iron Pipe, Section 39.

Pipes, special castings and valves,	$30,312 76
Laying pipes, including pipe-laying materials and earth excavation,	11,516 63
Rock excavation,	2,742 00
Valve chambers and concrete for bracing curves, and foundation for paving,	1,155 00
Work in connection with changes in underground structures,	1,794 72
Filling and testing main and preparing it for service,	1,602 81
Engineering and preliminary,	2,032 76
Total,	$51,156 68

Cost per foot, $4.82.

6,810 Feet of 20-inch Cast-iron Pipe, Section 40.

Pipes, special castings and valves,	$17,884 60
Laying pipes, including pipe-laying materials and earth excavation,	6,049 41
Rock excavation,	2,545 00
Valve chambers and concrete for bracing curves,	714 00
Work in connection with changes in underground structures,	599 59
Filling and testing main and preparing it for service,	889 43
Engineering and preliminary,	1,271 45
Total,	$29,953 48

Cost per foot, $4.40.

3,063.2 Feet of 20-inch Cast-iron Pipe, including 131.5 Feet of Flexible Jointed Pipe under 4-track Steam Railroad, Section 41.

Pipes, special castings and valves,	$8,037 53
Laying pipes, including pipe-laying materials and earth excavation,	5,094 61
Rock excavation,	145 00
Valve chambers and concrete for bracing curves,	482 00
Work in connection with changes in underground structures,	373 33
Making connection, building embankment over 600 feet of pipe line, testing and preparing line for service,	846 58
Engineering and preliminary,	1,078 77
Total,	$16,057 82

Cost per foot, $5.24.

Hyde Park Pumping Station — excavating and grading Lot and for Side Track, and constructing Concrete Foundations, etc.

Cast iron pipes and special castings,	$106 03
Excavating and grading, 4,006 cubic yards at 49.4 cents,	1,978 34
Concrete foundation walls, 339 cubic yards at $8.35 per cubic yard,	2,516 90
Gravel screened for concrete and not used,	363 65
Laying sewers, drains and miscellaneous work,	810 57
Engineering and preliminary,	2,608 11
Real estate, legal conveyancing and expert,	7,032 78
Total,	$15,416 38

Hydro-Electric Plant.

In September, 1910, a contract was made by the Board with the Connecticut River Transmission Company, under which the Board agreed to furnish for a period of five years electrical energy to be developed at the Wachusett Dam in Clinton, by utilizing the fall of water drawn from the Wachusett Reservoir into the Aqueduct for use in the Metropolitan District.

On November 9, 1910, a contract was made with the S. Morgan Smith Company, of York, Pa., to furnish and install in the power house which was built in 1904, 4 hydraulic turbines and 4 electric generators, with a small generator to be used as an exciter, with the necessary wiring and switchboard. Contracts were also made for furnishing 4 48-inch hydraulic lift valves, 4 48-inch Venturi meters, and about 113 tons of castings 48 inches and 60 inches in diameter, for use in the penstocks supplying water to the turbines.

In February, the Niles-Bement-Pond Co. of Philadelphia completed the erection of a hand-operated traveling crane, for use in connection with the erection and maintenance of the power plant.

Work upon concrete foundations for the wheels and generators and for the floor of the power-house was begun by the maintenance department in the latter part of February. The large penstock castings arrived in March, and the work of setting them began immediately. During April and May the work of installing the penstock valves, Venturi meters, electric generators and switchboard, and of constructing the concrete foundations and floor, were in active progress, and during the last week of the month one of the turbines was received and its erection was begun.

The erection of the turbines and generators, the construction of a lightning arrester house and of underground and overhead transmission lines connecting the power-house with the lines of the Connecticut River Transmission Company were in progress during the months of June and July. On the first of August the plant was substantially finished, and between August 3 and 9 one of the turbines was tested to determine its efficiency.

The plant consists of 4 hydraulic turbines of the horizontal shaft, spiral case type, each equipped with a Type Q Lombard governor. Each turbine was guaranteed to develop 1,200 horse-power. The contract provided that the turbines, when revolving at a speed of 400 revolutions per minute under a net head of 90 feet, and when discharging, respectively, 73, 122, 138 and 155 cubic feet per second, should give an average efficiency of 82 per cent.

The average efficiency of the turbines as determined by Prof. C. M. Allen of Worcester, was 79.4 per cent., measuring the discharge into the Wachusett Aqueduct by the use of a current meter; and 81.6 per cent., measuring the discharge by the use of a pitometer placed in the penstock pipe. The average of these efficiencies was assumed to be the correct result in the settlement with the contractor.

The water supplying each of the wheels flows from the reservoir into a masonry chamber built in the dam, which is provided with screens, stop-planks and sluice valves, thence through a vertical well 7 feet in diameter extending to a depth of 111 feet below high water in the reservoir, thence through a 48-inch cast iron pipe extending horizontally 114 feet through the dam into a building in which are located the turbines and generators, as well as connections with the Wachusett Aqueduct and with waste pipes for conveying the water to the river below the dam.

In each of the 4 pipes leading to the wheels there has been placed a special type of Venturi meter furnished by the Builders Iron Foundry of Providence, R. I. These meters afford means for measuring the quantity of water used by each of the turbines, as well as the quantity drawn from the Reservoir for the supply of the Metropolitan District.

Each meter consists of a throat section 40 inches in diameter, 10 feet 4 inches long, made in two sections for convenience in inserting in the 48-inch pipes, and an upstream pressure chamber, consisting of a ring of 3-inch brass pipe set in a recess cut in the brick wall of the 7-foot diameter vertical wells. The distance from the throat of the meter to the pressure chamber is about 90 feet. Water is admitted to the upstream pressure chamber through 12 ½-inch openings in brass plates which are set flush with the sides of the well; and the pressures, both from the pressure chamber in the vertical well and from the throat of the meter, are transmitted to the recording instruments in the power station through ¾-inch diameter brass pipes.

The recording instruments have three dials; one indicating the rate of flow in million gallons per day, one for continuously recording this rate upon a chart, and one for registering the total flow through the meter.

Tests of these meters made by careful current meter measurements of the flow in the Wachusett Aqueduct, indicate that for rates of flow between 48,000,000 and 110,000,000 gallons in 24 hours the meters will register and record the flow within 2 per cent. of accuracy.

The wheels and generators are supported on a foundation of heavy concrete masonry forming wells, into some of which the draft tubes from the turbines discharge, while others contain valves controlling the flow of water.

In each penstock directly under the turbine there is placed a 48-inch valve operated by water pressure by means of a 24-inch diameter hydraulic piston. These valves, four in number, were furnished by the Pratt & Cady Company, of Hartford, Conn., for $1,267 each.

The generators and switchboard were furnished and erected by the Westinghouse Electric & Mfg. Co. of Pittsburg under a subcontract with the S. Morgan Smith Company.

There are four 1,000 kilo-volt-ampere horizontal-shaft machines, each directly connected with a turbine and delivering 3-phase 60-cycle current at a pressure of 13,800 volts. The available head on the wheels will be from 80 to 100 feet, depending upon the elevation of the water in the reservoir and the quantity flowing in the aqueduct.

The plant also includes a 110 horse-power hydraulic turbine furnished by the S. Morgan Smith Company, and a 90 horse-power turbine furnished by the Holyoke Machine Company, each of which is directly connected with a 125-volt direct current Westinghouse generator used in exciting the large alternating current generators, in operating the motors used for pumping out wells, and in operating the electric crane in the upper gate house. The energy developed by the main units is conveyed for a distance of 815 feet from the power house through two lines of 3-conductor paper insulated lead covered cable. Each conductor is composed of 19 strands of copper wire and has a conductivity equivalent to a solid No. 0 B. & S. gage wire. The cables were tested at the factory under a pressure of 30,000 volts and guaranteed for 5 years. Each cable was laid in a 3½-inch diameter

Orangeburg fiber conduit laid in Portland cement concrete. In connection with the transmission line a twin conductor lead-covered telephone cable was laid in a 2-inch diameter Orangeburg fiber conduit. The underground cables terminate at a point on the side of the waste channel near the Central Massachusetts Railroad. At this point is located a building 20 feet long and 14 feet wide, constructed of Portland cement concrete with a roof of red Imperial Spanish tile. This building contains the apparatus required for arresting electric currents due to lightning and preventing injury to the cables, generators and other apparatus at the power house. Between the lightning arrester house and the transmission line of the Connecticut River Transmission Company there is a pole line 600 feet long, supporting 6 lines of No. 1 7-strand bare copper wire, 1 No. 4 copper guard wire and 2 No. 10 telephone wires.

The concrete floor of the room occupied by the wheels and generators is covered with selected red American Promenade floor tiles. The cost of the plant, including the concrete foundations and tile floor, was as follows: —

4 1,200 H. P. turbines, 4 1,000 K. V. A. generators, 1 110 H. P. exciter turbine, 2 exciter generators and electric equipment furnished and installed by S. Morgan Smith Co. and Westinghouse Electric & Mfg. Co.,		$69,639 62
Lombard governor on exciter turbine,		935 12
Lightning arrester station,		2,348 44
Underground transmission line,		2,693 47
Overhead transmission line,		949 30
Labor and materials furnished in connection with the wiring in the building,		2,022 98
Penstock pipes and valves: —		
4 48-inch valves,	$5,068 00	
Special castings,	7,474 40	
Installing castings and valves,	2,832 59	
		15,374 99
4 Venturi meters and installation of same,		6,211 94
Floor of power station, including concrete foundations for turbines and generators,		7,883 29
Traveling crane,		2,500 00
Miscellaneous labor and materials,		3,020 27
Engineering,		9,521 06
		$123,100 48

The total includes the cost of four Venturi meters which are used in measuring the water drawn from the reservoir.

MISCELLANEOUS CONSTRUCTION.

For the purpose of increasing the capacity of the mains leading from the high service engines to the Fisher and Waban Hill reservoirs, about 45 feet of 20-inch and 24-inch pipes in front of Chestnut Hill Pumping Station No. 1 have been removed, and 200 feet of 36-inch pipe, connected with the old 30-inch main, have been laid in front of the station and connected with the 36-inch main leading to Waban Hill Reservoir. This work was done in May, at a cost of $3,880.76.

A Hersey detector meter, Type F.M., size 6 inches x 3 inches, was installed in January on the Fellsway at Fells Avenue, Medford, for use in measuring the water used in a small section of that city known as Boulevard Heights.

Venturi meters and registers have been set at Cleveland Circle in Brighton, and at the Hyde Park Pumping Station, and a Hersey detector meter and Ross regulating valve have been set at the corner of Summit Street and Milton Avenue in Hyde Park, for use in measuring the quantity used, and controlling the pressure in a small section of Hyde Park which is to be supplied from the southern extra high service.

ENGINEERING.

The work of the engineering force chargeable to construction has included the preparation of plans and specifications and the superintendence of work which has been in progress under twenty contracts aggregating about $300,000 in value.

The principal items of work have been the 76-inch cement-lined steel pipe line and concrete-lined pressure tunnel in Newton, the hydro-electric plant at the Wachusett Dam, including turbines, generators, valves and castings, the new pumping engine at Chestnut Hill Pumping Station No. 2, and the pipes, valves, pipe laying, pumping station and machinery for the extension of the works to Hyde Park. Preliminary studies, including estimates of cost, have been made for reservoirs in the Blue Hills Reservation in connection with the southern extra high service system and for pipe lines to supply water to the town of Braintree.

MAINTENANCE.

Rainfall and Yield.

The rainfall on the Wachusett watershed was 38.73 inches and on the Sudbury watershed 38.38 inches. Although the rainfall was somewhat larger than in 1910, it was so distributed throughout the year that both the percentage and total amount collected were smaller than during any year since records have been kept. On the Wachusett watershed 37 per cent. of the rainfall, equivalent to 14.33 inches, was collected, and on the Sudbury watershed 28.2 per cent., equivalent to 10.8 inches. The rainfall, rainfall collected, and yield in gallons per day per square mile for the past four years, as compared with the corresponding figures for the years 1880 to 1883, inclusive, which is the period of lowest previous record, are as follows: —

Year.	Sudbury River Watershed.			Wachusett Watershed.		
	Rainfall (Inches).	Rainfall collected (Inches).	Yield (Gallons per Day per Square Mile).	Rainfall (Inches).	Rainfall collected (Inches).	Yield (Gallons per Day per Square Mile).
1908,	36.15	14.62	694,000	37.83	17.84	847,000
1909,	41.75	13.13	625,000	44.50	19.27	918,000
1910,	35.64	11.96	570,000	37.85	17.39	828,000
1911,	38.38	10.80	514,000	38.73	14.32	682,000
Averages,	37.98	12.63	600,750	39.73	17.20	818,750
1880,	38.18	12.18	578,000	-	-	-
1881,	44.17	20.57	979,000	-	-	-
1882,	39.39	18.10	862,000	-	-	-
1883,	32.78	11.19	533,000	-	-	-
Averages,	38.63	15.51	738,000	-	-	-
Average for 37 years,	-	-	1,013,000	-	-	-
Average for 15 years,	-	-	-	-	-	1,107,000

Storage Reservoirs.

On January 1, 1911, the storage reservoirs contained 59,327,000,000 gallons, which is 21,581,900,000 gallons less than their capacity when full. By reason of the small rainfall during the early part of the year there was no gain in storage until after the 14th of March. During the latter half of March and the month of April there was a gain in the amount of storage, but the Wachusett Reservoir did not fill during the spring and the maximum storage, which occurred on May 2, was 67,953,900,000 gallons. This was about 10,000,000,000 gallons less than the maximum during any previous year since 1908, when the Wachusett Reservoir was first filled. From May 2 until October 15 there was a practically continuous loss of storage, interrupted for two weeks by a heavy rainfall on June 5 and 6, and for one week, by a rainfall of 3½ inches during the last week in August. On October 18 the reservoirs contained 55,503,900,000 gallons of water. A rainfall of about 10½ inches during the last two and a half months of the year caused a gain in storage of 4,476,100,000 gallons, and on January 1, 1912, the reservoirs contained 653,000,000 gallons more than at the beginning of the previous year.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month: —

Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.

DATE.	In Wachusett Reservoir (Gallons).	In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons).	In All Other Storage Reservoirs (Gallons).	Total (Gallons).
1911.				
January 1,	45,610,400,000	7,890,400,000	5,826,200,000	59,327,000,000
February 1,	44,934,500,000	7,898,100,000	6,156,900,000	58,989,500,000
March 1,	45,416,100,000	7,694,800,000	6,057,900,000	59,168,800,000
April 1,	48,736,900,000	7,724,100,000	6,429,400,000	62,890,400,000
May 1,	53,705,700,000	7,200,500,000	6,974,800,000	67,881,000,000
June 1,	54,667,000,000	5,996,100,000	6,204,200,000	66,867,300,000
July 1,	54,153,200,000	6,009,400,000	5,189,700,000	65,352,300,000
August 1,	51,921,000,000	6,569,800,000	3,297,400,000	61,788,200,000
September 1,	49,806,000,000	6,406,000,000	2,745,700,000	58,957,700,000
October 1,	48,186,800,000	6,126,000,000	2,236,900,000	56,549,700,000
November 1,	48,027,400,000	5,730,900,000	2,358,900,000	56,117,200,000
December 1,	47,755,500,000	6,710,000,000	3,065,900,000	57,531,400,000
1912.				
January 1,	48,910,000,000	6,980,900,000	4,089,100,000	59,980,000,000

Wachusett Reservoir. — At the beginning of the year the water in this reservoir was at elevation 379.35, or 15.65 feet below high-water mark. The low-water mark for the year was 378.52 on January 27. On March 14 the elevation of the water was 378.69, after which date the reservoir rose until May 18, when it stood at elevation 387.09. The highest point for the year was reached on June

10, when the elevation was 387.41, or 7.59 feet below high-water mark. Between this date and the middle of October the reservoir fell 6.35 feet. During the remainder of the year the reservoir surface varied but little in elevation, but rose about 12 inches during the latter half of December. At the end of the year the reservoir was 2.95 feet higher than at the beginning, and contained 48,910,000,000 gallons, a net gain in storage of 3,299,600,000 gallons during the year.

The reservoir bottom between elevations 382 and 398 covering an area of over 600 acres, was cleaned between September 25 and November 8, for the first time since 1908. The perennials which had grown during the past three years were removed by pulling or grubbing; the annuals were pulled or mowed; the tree stumps, roots, logs and miscellaneous debris brought into the reservoir by flood water or unearthed by wave action on the shores were collected, and the entire surface was raked, all refuse burned and the residue buried or removed outside the limits of the reservoir. This work was done at a cost of $2,165.88.

No additional removal of soil along the shores of the reservoir has been necessary during the past year, but the timber was cut from a strip 50 feet wide and 975 feet long along the Sawyers Mills Bluff, in anticipation of further washing away of the shore at that place.

Wachusett Dam and Grounds. — The structures and grounds at the dam are in good condition. The hauling of heavy machinery and supplies to the lower gate house, in connection with the installation of the hydro-electric plant, and the excavation of trenches for electric conduits, has made necessary the repairing of the roadways on the grounds as well as the public highway leading to the dam from Boylston Street. By arrangement with the Road Commissioners of Clinton, this department furnished and placed screened gravel on 5,100 linear feet of roadway 20 feet wide, 960 feet of which was a town road but used almost exclusively by the Commonwealth, and the town of Clinton furnished a steam roller and wet and rolled the roadway for its entire length. These repairs were made in September at a cost of $818.11. The lawn at the foot of the dam, between the power house and the west hillside, has been regraded and a driveway built to afford access for teams to the door at the west end of the power station.

A one-story, concrete building, 32 feet x 23 feet, with a red tile roof, has been built on the grounds for use as a garage, in which to store the two automobiles used by the department, and as a storehouse for tools used in caring for the grounds about the dam. The cost of this building was $3,079.73.

Six additional screens of standard design have been made for use in the upper gate chamber, it having been found necessary to provide additional screen area in connection with the economical operation of the power plant.

Care and Improvement of the Wachusett Watershed. — In addition to the work described under the heads of Forestry and Swamp Drainage, the conditions on the Wachusett watershed have been improved by the acquisition of 130.408 acres of land, a large portion of which is of a swampy character and located on the line of brooks which flow directly into the reservoir.

Waushacum Brook, which forms the outlet of the Waushacum ponds and is one of the principal feeders of the Wachusett Reservoir, extends for over a mile through three of the properties recently purchased. For the whole distance the channel of the brook has been improved by widening, deepening and straightening, and a margin 15 feet wide has been cleared on both sides of the brook. This work was done at a cost of $666.45.

Thirty-five stone bounds have been set, marking the boundary of property purchased.

An old dam across Malden Brook, in West Boylston, on property formerly owned by Mary L. Warner, has been torn down and the brook cleaned and improved, thus removing a small objectionable pond and swamp.

The timber portion of the dam across the Quinepoxet River just above the site of Warfield's Mill has been removed and burned and the rock portion of the dam levelled so as to prevent the storage of water back of the dam during times of low water in the river.

The original plank covering of a large cesspool constructed to receive drainage from a barn on the premises of Andrew J. Scarlett, in West Boylston, has been replaced by a more permanent cover made of Portland cement concrete slabs supported on granite sills.

The standing and rowen grass from about 375 acres of land around the reservoir was sold for $2,690.

Emergency Supply for City of Worcester. — During the months of September and October the city of Worcester, by permission of the

Board, constructed upon the shore of the Wachusett Reservoir, at South Bay, in the town of West Boylston, a pumping plant designed to furnish an emergency supply of water to that city. The plant consists of three four-stage centrifugal pumps, each having a capacity of 2,000,000 gallons in 24 hours, connected by a belt to a 250 H. P. General Electric motor. Two additional motors were installed and foundations constructed for two additional pumps for use if they should be required. Each pump draws its supply through a 10-inch suction main supported on a timber platform extending into the reservoir, and all the pumps discharge into a common force main, 30 inches in diameter, through which the water is carried about 2¼ miles and discharged into the distribution system of the city of Worcester. The machinery is enclosed in a one-story wooden building 46 feet 2 inches wide x 69 feet 4 inches long, supported on concrete foundations. Pumping from the reservoir to the city of Worcester was begun at 3 P.M. on October 24 and continued, with some intermissions, until November 11, the total amount pumped being 62,440,000 gallons, for which the city of Worcester paid $1,810.76. The plant was operated by electricity furnished by the Connecticut River Transmission Company.

Sudbury Reservoir. — From January 1 to April 23 this reservoir was full, and during the greater portion of this period water was flowing over the crest of the dam. During the succeeding four weeks the reservoir was lowered about 4 feet, and from May 20 until November 20 the reservoir was kept between 3 and 5.5 feet below the crest of the dam. At the end of the year the water surface was 2 feet below the crest.

The wells, from which water is drawn to supply the Bigelow and Cratty houses owned by the Board and occupied by its employés, have been deepened and repairs made at both of these houses, also at the attendant's house at the Sudbury Dam.

A wire fence 825 feet long has been built on the line between property of the Board and Oren P. Walker, near the Marlborough filter-beds.

At the Sudbury Dam about 9 cubic yards of Portland cement concrete were used in filling holes at the foot of the overflow. Steel plates 19 inches x 25 inches in size, were placed in the sides of the casting below one of the pipe gates in the gate-house, and the iron standards for supporting flash-boards on the crest of the overflow have been painted.

Framingham Reservoirs Nos. 1, 2 and 3. — From June 18 to October 21 the surface of Framingham Reservoir No. 1 was below the crest of the dam, due to the discharge from this reservoir into the river of 1,500,000 gallons per day, as required by law. The lowest point reached was 1.17 feet below the crest of the dam, on August 25. At the end of the year water was being wasted over the outlet dam.

The water in Framingham Reservoir No. 2 was above the level of the crest of the dam from January 1 to July 24, with the exception of a few days in February and March. During August the surface was about 5 feet below the stone crest. During September the reservoir filled and for the remainder of the year the surface remained at or near high-water mark.

The elevation of the water in Framingham Reservoir No. 3 is controlled by the draft for the supply of the Metropolitan District and the quantity delivered into the reservoir from the Sudbury Reservoir. During the greater part of the year the surface of this reservoir was kept between one and two feet below the crest of the dam. The only time that any water was allowed to flow from this reservoir into Framingham Reservoir No. 1 was for a few hours on March 16, when the water rose above the top of the flash-boards on the dam.

The work of filling a shallow area at the head of Framingham Reservoir No. 3, which was begun in 1910, has been completed. The surface of the fill has been covered with about 6 inches of loam and sowed with grass seed. There were used in the fill 3,600 cubic yards of material at a cost of about 25 cents per cubic yard.

Advantage was taken of the low stage of the water in Framingham Reservoir No. 2 to clean and paint the upper pipe gate in the gatehouse. Granite bounds were set at 57 angle points on the property lines around Framingham Reservoir No. 2.

The embankments of the three dams were dressed with chemical fertilizer, and, judging from the appearance of the grass, the embankments can be kept in good condition at less expense by the use of chemical fertilizer than by the use of stable manure.

Ashland Reservoir. — At the beginning of the year the reservoir was full and overflowing, and it continued to overflow nearly all of the time until April 27. During the following three months water was drawn from this reservoir for use in the Metropolitan District at rates of from 10,000,000 to 30,000,000 gallons per day. On July 24, when the gates were closed, the surface of the reservoir was 33 feet below high-water mark, and the storage had been reduced from 1,421,900,000 to 157,200,000 gallons. At the end of the year this reservoir had risen to elevation 208.51 and contained 629,200,000 gallons. The sluice gates, gate stems and brackets were cleaned and painted and the stop-planks in the gate-house overflow, twenty in number, 4 feet 6 inches long, which were in poor condition, have been renewed. The embankment at the dam was given a dressing of chemical fertilizer.

Hopkinton Reservoir. — The water in this reservoir was 0.16 of a foot above the crest of the waste-way at the beginning of the year. From the middle of February to the middle of March 413,100,000 gallons of water were drawn in excess of the yield of the watershed, and the surface of the reservoir lowered 7.04 feet. After March 21 the reservoir surface rose steadily and the highest elevation for the year was reached on May 5, when the water stood at elevation 304.83, or 0.17 of a foot below high-water mark. On May 5 the valves on the outlet pipe were opened and on June 1 the reservoir surface had fallen 7½ feet, on July 1, 11 feet additional, and on July 24, when the outlet valves were closed, the reservoir was 32.82 feet below high-water mark, and contained but 138,000,000 gallons.

Advantage was taken of the low level of the water in the reservoir to clean and paint the sluice gates at the dam, with the exception of the lower guard gate, including the gates controlling the flow on the filter-beds. The filter-beds were harrowed in the spring and a growth of weeds and grass mowed and burned in the fall. The embankment of the dam was dressed with chemical fertilizer.

Whitehall Reservoir. — On January 1, 1911, the surface of this reservoir was at elevation 335.70. Water was drawn from the reservoir continuously from August 20 to October 3, to reinforce the storage in Framingham Reservoir No. 2, from which water was at that time being drawn for the supply of the Metropolitan District. This draft lowered the reservoir 2.15 feet. At the end of the year the reservoir surface was at elevation 336.13, or 1.78 feet below high water.

A portion of the retaining wall on the east side of the flume which passes through the outlet dam collapsed, and the old wall has been taken down and rebuilt in a more substantial manner. Five summer cottages have been built and there are now 59 cottages located near the shore of the reservoir.

Farm Pond. — No water was drawn from this pond during the year for use in the Metropolitan District, none was wasted from it to the Sudbury River and none supplied to it from the Sudbury Aqueduct. The town of Framingham has drawn the greater part of its supply from filter galleries located on the shore of the pond, and in June changed the connections between the filter galleries and the pumps so as to make it possible to draw the water from the filter galleries at a lower level.

In December an 8-inch Hersey proportional meter was set on the pipe connecting the Sudbury Aqueduct with the pumps supplying the town of Framingham, so that hereafter a more accurate measurement will be obtained of the quantity drawn from the aqueduct by the town of Framingham.

The total quantity of water used by Framingham was 264,000,000 gallons, of which 41,300,000 gallons were drawn from the Sudbury Aqueduct and the remainder from the filter galleries.

Lake Cochituate. — At the beginning of the year the water in the lake was at elevation 141.19, or 3.17 feet below high water. The lake was filled in the latter part of April and remained at or near high-water mark until July 1; from that date until October 23 water was drawn from the lake for the supply of the Metropolitan District, and its surface lowered about 8.5 feet, to elevation 135.81. During November and December the surface of the lake rose 4 feet and on January 1, 1912, stood at elevation 140.21.

The stone coping of the retaining wall alongside the driveway leading from Pond Street to the effluent gate-house has been reset for a distance of 390 feet, and willow cuttings set in loam back of the wall for the purpose of forming a hedge alongside the driveway.

An area of about half an acre, lying between Speene Street and the shore at the south end of the lake, on land belonging to E. E. Wilgus, which was slightly below the high-water level of the lake, has been filled so that it is now not less than 9 inches above high-water mark. This work was done at a cost of about $312.

While the water was at a low stage, the shores of the lake were cleaned at several points and the channel under Worcester Street was deepened so that water could be drawn from the upper end of the lake to a greater depth.

WORKS FOR DIVERTING SURFACE DRAINAGE OF COCHITUATE VILLAGE FROM LAKE COCHITUATE TO THE SUDBURY RIVER.

The construction of these works was nearly completed in 1910 and they were described in the report for that year. Since January 13, 1911, when the drains were placed in service, the surface drainage from about 140 acres, on which there is a population of 700, has been carried to Bannister's Brook, from which it flows to the Sudbury River. As soon as the frost left the ground in the spring the contractor completed his work by laying 15 feet of 12-inch pipe, surfacing the trenches and repairing concrete masonry which had been injured by freezing. For a distance of about 450 feet the open channel was carried through a shallow pond which was partially filled by the contractor with surplus material from other parts of the work. As there was not enough of the surplus material to complete the filling of the pond 1,267 cubic yards of gravel and loam were purchased at a cost of 48 cents per yard. This material was placed and the area graded by the regular maintenance force, who also constructed 1,150 feet of ditches, 700 feet of which are provided with plank bottom and paved side slopes.

On account of the sliding of the very fine material forming the side slopes of the open channel through land of Charles H. McIntyre it has been found necessary to repair the paved slopes and clean several hundred feet of the open channel. The experience of the winter of 1910–11 shows that Bannister's Brook brings down considerable fine sand, which deposits in a portion of the drain below the Cochituate Road, from which it cannot be easily removed. It is now proposed to construct a settling basin in which the sand will be deposited before entering the new channel.

Fences, having an aggregate length of 232 feet, have been built on both sides of the Cochituate Road and Speene Street, where the roads cross the open channel.

The cost of the drainage system to December 31, 1911, was $34,558.02, as follows: —

5,876 feet of open channel,	$13,239 88
Cost per foot, $2.25.	
3,454 feet of 36-inch x 33-inch concrete covered channel,	13,606 76
Cost per foot, $3.94.	
957 feet 24-inch, 167.5 feet 18-inch and 367 feet 12-inch pipe, 9 manholes and 14 catch basins,	3,828 20
Cost per foot, $2.57.	
2 culverts,	812 69
Filling pond hole and constructing ditches in same,	2,059 39
Miscellaneous,	1,011 10
	$34,558 02

SOURCES FROM WHICH WATER FOR THE SUPPLY OF THE METROPOLITAN DISTRICT HAS BEEN TAKEN.

An average of 65,580,000 gallons of water per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. This was 37,566,000 gallons per day less than during the previous year, due to the use of a larger proportion of water from the Sudbury and Cochituate sources, and to a reduction in the total consumption. For the use of the Metropolitan District an average of 29,839,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct, an average of 22,792,000 gallons per day from Framingham Reservoir No. 2 and of 47,768,000 gallons per day from Framingham Reservoir No. 3 through the Sudbury Aqueduct, and an average of 9,522,000 gallons per day from Lake Cochituate through the Cochituate Aqueduct. The drainage area of Spot Pond furnished 208,000 gallons per day.

The quantity of water drawn from Framingham Reservoir No. 2 during the past year was very much larger than in any year since 1898, and of the quantity drawn from this source 8,300,000 gallons per day were drawn from the storage in the Ashland, Hopkinton and Whitehall reservoirs.

AQUEDUCTS.

The *Wachusett Aqueduct* was in use 4,755 hours and 12 minutes, equivalent to 198.13 days. Since August 10, when the hydro-electric plant was placed in operation, the greater part of the water supplied to the Sudbury Reservoir has been passed through the turbines before entering the aqueduct. The interior of the aqueduct was thoroughly cleaned between April 10 and 15.

For considerable distances the fences built at the time of the construction of the aqueduct, having three 1-inch x 6-inch horizontal spruce rails, have become decayed, and 2,146 feet of this kind of fencing have been replaced by No. 65 Wheelock wire fence with chestnut posts, and 2,990 feet of the old fence have been repaired with material saved from the rebuilt portion.

The iron fences at the dams and highway crossings of the open channel, and the ironwork in the terminal chamber have been given one coat of Smith's Durable Metal Compound.

The town of Berlin has formally accepted the relocation of Crosby and Jones roads where they cross the aqueduct.

An area of about 1 acre along 1,200 feet of the aqueduct land immediately east of Bartlett Street in Northborough, and an area of 6 acres on the southerly side of the open channel in Marlborough, about ¼ of a mile below the terminal chamber, have been cleared of trees, which were cut into cord wood.

The weir at the terminal chamber, which has been used for measuring the flow through the aqueduct, was removed on September 25, and since that time the flow has been measured by means of four Venturi meters placed in the 48-inch outlet pipes at the Wachusett Dam.

The *Sudbury Aqueduct* was in use continuously throughout the year and delivered into Chestnut Hill Reservoir a daily average of 70,560,000 gallons, which was 14,473,000 gallons less than the daily average in 1910.

The joints in the granite masonry in the substructure of the waste-weir at Fuller's Brook and in the double culvert under the waste-weir were cut out and repointed, also the joints in the faces of the abutments at the top of Waban Bridge.

The high board fence crossing the aqueduct at the westerly end of Echo Bridge, the remains of fences which had been burned by grass fires on both sides of the aqueduct between Dover Street and Waban Bridge, and quite a number of unnecessary cross fences along the line of the aqueduct have been removed.

Fourteen alignment stones and 63 land bounds which were too low or out of position have been reset, and 13 bounds have been set at angle points where no bounds existed.

The heating plant formerly used in keeping the interior of the

Waban Bridge arches free from ice during the winter has been removed, as it has not been required since the lead lining was placed in the aqueduct.

The leakage at Echo Bridge, previously reported, increases from year to year, and the aqueduct at this bridge should be lined during the coming season.

Water was drawn through the *Cochituate Aqueduct* for the supply of the District on 210 days during the year, the total quantity drawn being 3,475,600,000 gallons, equivalent to a daily average of 9,522,000 gallons for the whole year.

The portion of the aqueduct between the Newton Centre wasteweir and the ventilator, a distance of 7,306 feet, was cleaned in June.

A small house which, for many years, has stood on the aqueduct land not far from Pleasant Street, in Newton, and an old barn on the T. V. Fitch estate, in Wellesley, a portion of which was on the aqueduct property, have been removed.

Chemical fertilizer has been placed on about half the area of the embankment slopes with satisfactory results.

A 6-inch water pipe has been laid across and over the aqueduct by the city of Newton on Waban Avenue opposite Nehoiden Road, and the town of Wellesley has laid a 6-inch water pipe across and over the aqueduct at Rice Street, Wellesley Hills. The city of Newton laid an 8-inch sewer over the aqueduct at the intersection of East and West Waban avenues, and a 6-inch sewer opposite the estate of E. E. Bessey on Beacon Street in Waban. These pipes were of cast-iron with leaded joints, for a distance of 24 feet on each side of the centre of the aqueduct.

The *Weston Aqueduct* was in continuous service between the Sudbury and Weston reservoirs throughout the year, with the exception of 1½ hours when the flow was stopped in order to examine gates and castings at the Sudbury Dam. The daily flow averaged 28,798,000 gallons until November 4, when the new 60-inch supply pipe line was placed in service, and 35,348,000 gallons after that date.

Rusted cable wire fencing has been replaced by No. 65 Wheelock wire fence for a distance of 1,644 feet in Weston between School Street and Connecticut Path, and 1,018 feet near the east end of tunnel No. 3.

Considerable work has been done in reseeding or planting with witch grass roots the aqueduct embankments between gaging chamber No. 2 and Elm Street, near siphon chambers Nos. 1 and 2 and west of School Street in Weston.

Chemical fertilizer has been spread on about half the area of the embankments along the line of the aqueduct.

PUMPING STATIONS.

Seventy-three per cent. of the water supplied to the Metropolitan District has been pumped at the two stations at Chestnut Hill Reservoir, and the remainder has been delivered by gravity. The total quantity pumped at all of the stations was 32,685,890,000 gallons, which was 4.17 per cent. less than during the preceding year.

The cost of operating the stations was $97,196.68, equivalent to $2.974 per million gallons pumped. The average cost of raising 1,000,000 gallons of water 1 foot high at all the stations was $0.0349, a slight increase above the cost in 1910.

Coal for use at the several stations has been purchased as follows: —

BY WHOM FURNISHED.	GROSS TONS.					Cost per Gross Ton, in Bins.[1]
	Chestnut Hill Pumping Station, No. 1.	Chestnut Hill Pumping Station, No. 2.	Spot Pond Station.	Arlington Station.	West Roxbury Station.	
Gorman-Leonard Coal Company, bituminous,	1,420.73	-	-	-	-	4.06
Gorman-Leonard Coal Company, bituminous,	199.89	-	-	-	-	4.03
Gorman-Leonard Coal Company, bituminous,	600.16	-	-	-	-	3.98
Gorman-Leonard Coal Company, bituminous,	-	1,797.60	-	-	-	3.95
New England Coal and Coke Company, bituminous.	-	257.61	-	-	-	3.94
Gorman-Leonard Coal Company, bituminous,	-	144.78	-	-	-	3.90
Madeira Hill Company, bituminous,	-	46.11	-	-	-	3.89
Gorman-Leonard Coal Company, bituminous,	-	1,778.27	-	-	-	3.86
Logan Coal Company, bituminous,	-	48.97	-	-	-	3.82
C. W. Claflin & Co., buckwheat anthracite,	540.30	-	-	-	-	2.88
C. W. Claflin & Co., buckwheat anthracite,	-	1,353.75	-	-	-	2.69

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[1] Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.

By whom furnished.	Gross Tons.					Cost per Gross Ton, in Bins.[1]
	Chestnut Hill Pumping Station, No. 1.	Chestnut Hill Pumping Station, No. 2.	Spot Pond Station.	Arlington Station.	West Roxbury Station.	
New England Coal and Coke Company, bituminous.	-	-	114.62	-	-	4.91
New England Coal and Coke Company, bituminous.	-	-	488.24	-	-	4.35
Locke Coal Company, screenings, . . .	-	-	446.87	-	-	2.50
Joseph Butler, screenings, ...	-	-	11.82	-	-	2.50
New England Coal and Coke Company, bituminous.	-	-	-	128.39	-	4.31
New England Coal and Coke Company, bituminous.	-	-	-	251.79	-	3.94
Philadelphia and Reading Coal and Iron Company, screenings.	-	-	-	91.00	-	2.72
Roxbury Coal Company, furnace, . . .	-	-	-	-	6.22	5.88
Roxbury Coal Company, pea, ...	-	-	-	-	94.71	5.13
Roxbury Coal Company, buckwheat anthracite, .	-	-	-	-	213.05	4.37
Total gross tons, bituminous, . . .	2,220.78	4,073.34	602.86	380.18	-	-
Total gross tons, anthracite, ...	540.30[2]	1,353.75[2]	-	-	313.98	-
Total gross tons, anthracite screenings, . .	-	-	458.69	91.00	-	-
Average price per gross ton, bituminous, - . .	4.03	3.90	4.46	4.06	-	-
Average price per gross ton, anthracite, . .	2.88[2]	2.69[2]	-	-	4.63	-
Average price per gross ton, anthracite screenings,	-	-	2.50	2.72	-	-

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[1] Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.
[2] Buckwheat.

The standard requirements in the contracts for the purchase of bituminous coal have been changed during the year for the purpose of improving the quality of the coal. The number of heat units required has been increased from 14,600 to 14,700, and the allowable percentage of ash has been decreased from 9 to 8.

The tests of the several kinds of coal burned at the Water Works stations indicate that the quality of the coal supplied during the past year has been higher than in previous years.

KIND OF COAL.	Number of Samples tested.	British Thermal Units.	Percentage of Volatile Matter.	Percentage of Ash.	Percentage of Moisture.
Beaver Run,	48	14,818	17.41	6.16	3.54
Sonman,	16	14,703	17.17	6.56	3.10
Pocahontas,	15	15,010	18.14	4.66	3.93
New River,	8	14,926	20.71	5.30	2.16
Vulcan,	4	14,890	20.53	5.79	2.32
Atlas,	2	14,906	20.38	5.65	3.56
Dunlo,	2	15,053	18.75	5.01	3.35
Spangler No. 4,	2	14,431	23.40	8.02	2.61
Logan,	1	14,783	17.83	6.64	3.69
South Fork,	1	14,730	18.08	6.69	3.93

CHESTNUT HILL PUMPING STATIONS.

In previous reports the two pumping stations at Chestnut Hill Reservoir have been designated as the Chestnut Hill High-service Pumping Station and the Chestnut Hill Low-service Pumping Station, for the reason that they contained engines used in pumping water consumed in the district designated by the title. During the past year an engine having a daily capacity of 40,000,000 gallons has been placed in the Low-service Station for use in supplying water to the high-service district. In this and subsequent reports the station which has been designated as the High-service Station will be designated as Chestnut Hill Pumping Station No. 1, and the station heretofore known as the Low-service Station will be known as Chestnut Hill Pumping Station No. 2. The following are statistics relating to operations at both of these stations: —

	Pumping Station No. 1.			Pumping Station No. 2.	Totals.
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Engine No. 12.	
Daily pumping capacity (gallons),	16,000,000[1]	20,000,000	30,000,000	40,000,000	106,000,000
Total quantity pumped (million gallons),	671.54	(Not operated during the year.)	5,804.62	5,352.11	11,828.27
Daily average quantity pumped (gallons),	1,840,000		15,903,000	14,663,000	32,406,000
Coal used in pumping (pounds),	1,169,770		4,428,994	3,636,115	9,234,879
Gallons pumped per pound of coal,	574.08		1,310.60	1,475.99	1,280.83
Average lift (feet),	128.14		127.77	123.34	125.79
Cost of pumping: —					
Labor,	$1,988 57		$9,521 05	$8,576 99	$20,086 61
Fuel,	2,674 59		8,542 46	6,238 76	17,455 81
Repairs,	190 45		1,031 08	634 61	1,856 14
Oil, waste and packing,	81 09		461 13	168 04	710 26
Small supplies,	59 57		286 79	101 50	447 86
Totals,	$4,994 27		$19,842 51	$15,719 90	$40,556 68
Cost per million gallons pumped,	7.437		3.418	2.937	3.429
Cost per million gallons raised 1 foot high,	.0580		.0268	.0238	.0273

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[1] 8,000,000 each.

	Chestnut Hill Pumping Station No. 2. — Engines Nos. 5, 6 and 7.
Daily pumping capacity each engine (gallons),	35,000,000
Total quantity pumped (gallons),	17,530,710,000
Daily average quantity pumped (gallons),	48,029,000
Total coal used (pounds),	6,597,460
Gallons pumped per pound of coal,	2,657.19
Average lift (feet),	46.34
Cost of pumping: —	
Labor,	$18,582 46
Fuel,	10,738 61
Repairs,	854 65
Oil, waste and packing,	362 02
Small supplies,	235 93
Total,	$30,773 67
Cost per million gallons pumped,	$1.7550
Cost per million gallons raised 1 foot high,	.0379

On account of irregularities in the operation of the engines pumping water for the southern high-service district, due to the installation of the new 40,000,000-gallon engine at Station No. 2, the cost per million gallons pumped to the reservoir by engines Nos. 1, 2 and 4 was somewhat larger than during the previous year.

A Uehling instrument for indicating and recording the percentage of carbonic acid CO_2 in the flue gases from the boilers, thus determining whether the fuel is being burned economically, was purchased and connected with the boilers in December. It is expected that the use of this instrument will result in a saving in the amount of coal used.

No expensive repairs have been made to the machinery in either of the stations.

Engine No. 12, although not yet tested and formally accepted, has been operated during a considerable portion of the year and has given a duty of between 150 and 160 million foot pounds per 100 pounds of coal.

The 48-inch and 60-inch pipes through which water is brought from the Chestnut Hill Reservoir into the pumping stations, together with the chambers in the gate-house at the reservoir, and the pump wells at Pumping Station No. 2, have been emptied and cleaned. The pipes were found to be coated with a heavy growth of Fredericella and Spongilla, a considerable portion of which dropped off the top and sides of the pipes when they were emptied and was washed out through the drain pipe. A considerable number of fresh water clams or mussels were found in the pipes and in the bottom of the gate-house. About 8 cubic yards of material were removed from 1,000 feet of 60-inch and 500 feet of 48-inch pipes. The sluice valves in the gate-house were cleaned and painted with red lead and oil.

The screen area in the gate-chamber has been increased from 167 square feet to 206 square feet, equivalent to 23 per cent., by substituting a screen for the stop-plank for a depth of 26 inches in each of the three passageways through which the water is drawn from the reservoir.

Spot Pond Pumping Station.

The following are statistics relating to operations at this station: —

Total quantity pumped (gallons),	2,770,220,000
Daily average quantity pumped (gallons),	7,590,000
Total coal used (pounds),	2,442,415
Gallons pumped per pound of coal,	1,134.21
Average lift (feet),	133.36
Engine No. 8 operated (hours),	72
Engine No. 9 operated (hours),	3,307
Quantity pumped by Engine No. 8 (gallons),	31,050,000
Quantity pumped by Engine No. 9 (gallons),	2,739,170,000

Cost of pumping: —

Labor,	$8,516 68
Fuel,	4,153 76
Repairs,	187 17
Oil, waste and packing,	235 49
Small supplies,	189 93
Total for station,	$13,283 03
Cost per million gallons pumped,	$4.795
Cost per million gallons raised 1 foot high,	.0359

The quantity of water pumped was 0.66 per cent. greater, while the cost of operating the station was 2.49 per cent. less than in 1910.

ARLINGTON PUMPING STATION.

The following are statistics relating to operations at this station: —

Total quantity pumped (gallons),	304,820,000
Daily average quantity pumped (gallons),	835,000
Total coal used (pounds),	1,089,306
Gallons pumped per pound of coal,	279.83
Average lift (feet),	282.88
Engine No. 10 operated (hours),	5,989
Engine No. 11 operated (hours),	1,168
Quantity pumped by Engine No. 10 (gallons),	265,740,000
Quantity pumped by Engine No. 11 (gallons),	39,080,000

Cost of pumping: —

Labor,	$4,694 92
Fuel,	1,836 00
Repairs,	299 36
Oil, waste and packing,	56 08
Small supplies,	292 20
Total for station,	$7,178 56
Cost per million gallons pumped,	$23.550
Cost per million gallons raised 1 foot high,	.0833

There was an increase of 7.89 per cent. in the quantity pumped and a decrease of 2.78 per cent. in the cost of operating the station as compared with the previous year.

The exterior woodwork of the building received a coat of paint early in December and the interior woodwork was being painted at the end of the year.

The side track, on which coal is delivered to the pumping station, has been repaired by the Boston & Maine Railroad at a cost of $110.46.

West Roxbury Pumping Station.

The following are statistics relating to operations at this station: —

Total quantity pumped (gallons),	251,870,000
Daily average quantity pumped (gallons),	690,000
Total coal used (pounds),	706,763
Gallons pumped per pound of coal,	356.37
Average lift (feet),	129.30
Engine No. 1 operated (hours),	236
Engine No. 2 operated (hours),	8,350
Engine No. 3 operated (hours),	246
Quantity pumped by Engine No. 1 (gallons),	6,360,000
Quantity pumped by Engine No. 2 (gallons),	232,900,000
Quantity pumped by Engine No. 3 (gallons),	12,610,000

Cost of pumping: —	
Labor,	$3,696 10
Fuel,	1,455 02
Repairs,	151 13
Oil, waste and packing,	42 03
Small supplies,	60 46
Total for station,	$5,404 74
Cost per million gallons pumped,	$21.459
Cost per million gallons raised 1 foot high,	.1660

The quantity pumped was 1.34 per cent. larger, while the cost of operating the station was 4.03 per cent. less than for the previous year.

Consumption of Water.

The daily average quantity of water consumed in the eighteen municipalities supplied from the Metropolitan Works during the year 1911, as measured by Venturi meters, was 109,994,800 gallons, equivalent to 105 gallons per capita in the district supplied. The daily average consumption was 2,097,300 gallons less than during the previous year, and 15,429,400 gallons less than during the year 1908. The per capita consumption has been reduced 18.6 per cent. in three years and is now as low as in 1898, when the Metropolitan Works were established.

The daily average quantity supplied to the Metropolitan Water District, as determined by pump measurement and by the flow in the Weston Aqueduct, and the estimated yield of Spot Pond was 110,456,000 gallons, equivalent to 105.5 gallons per inhabitant. The difference between the quantity delivered by the aqueducts and that measured by meters to the several municipalities is due to difference in the methods of measurement, to leakage from the Metropolitan Water Works reservoirs and pipes and to the use of water at the Chestnut Hill and Spot Pond pumping stations.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the years 1910 and 1911, as measured by meters, was as follows: —

	Estimated Population, 1911.	Daily Average Consumption.					
		1910.		1911.		Increase in Gallons.	Decrease in Gallons.
		Gallons.	Gallons per Capita.	Gallons.	Gallons per Capita.		
Boston,	688,520	87,346,700	130	85,571,500	124	-	1,775,200
Somerville,	79,360	6,189,500	80	5,899,100	74	-	290,400
Malden,	45,780	1,874,400	42	1,971,300	43	96,900	-
Chelsea,	33,630	2,834,500	87	2,701,400	80	-	133,100
Everett,	34,910	2,575,600	76	2,557,800	73	-	17,800
Quincy,	33,760	2,891,900	88	2,925,400	87	33,500	-
Medford,	24,100	1,422,400	61	1,207,100	50	-	215,300
Melrose,	16,070	1,005,700	64	1,012,500	63	6,800	-
Revere,	19,240	1,313,400	71	1,439,400	75	126,000	-
Watertown,	13,330	880,800	68	889,200	67	8,400	-
Arlington,	11,700	938,200	83	983,200	84	45,000	-
Milton,	8,140	309,200	39	317,700	39	8,500	-
Winthrop,	10,670	649,500	63	597,800	56	-	51,700
Stoneham,	7,360	650,800	91	573,300	78	-	77,500
Belmont,	5,840	329,500	59	415,500	71	86,000	-
Lexington,	4,590	345,500	78	352,900	77	7,400	-
Nahant,	2,340	121,700	58	152,000	65	30,300	-
Swampscott,	7,290	412,800	59	427,700	59	14,900	-
District,	1,046,630	112,092,100	110	109,994,800	105	-	2,097,300

The consumption in the several districts was as follows: —

	Gallons per Day, 1911.	Decrease (Gallons per Day).	Percentage of Decrease.
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, .	45,420,600	753,000[1]	1.69[1]
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, ...	24,731,900	1,300,500	5.00
Southern high-service district, embracing the high-service districts of Boston, Quincy, Watertown, and portions of Belmont and Milton, ...	30,931,600	1,712,800	5.25
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, ...	7,385,500	92,900[1]	1.27[1]
Southern extra high-service district, embracing the higher portions of West Roxbury and Milton, ...	690,100	9,100[1]	1.34[1]
Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont, ...	835,100	61,000[1]	7.88[1]
Totals, ...	109,994,800	2,097,300	1.87

[1] Increase.

The diagram facing this page shows graphically the average daily consumption and the rate of consumption between the hours of 1 and 4 A.M. in the district supplied by the Metropolitan Works for each week during the years 1910 and 1911.

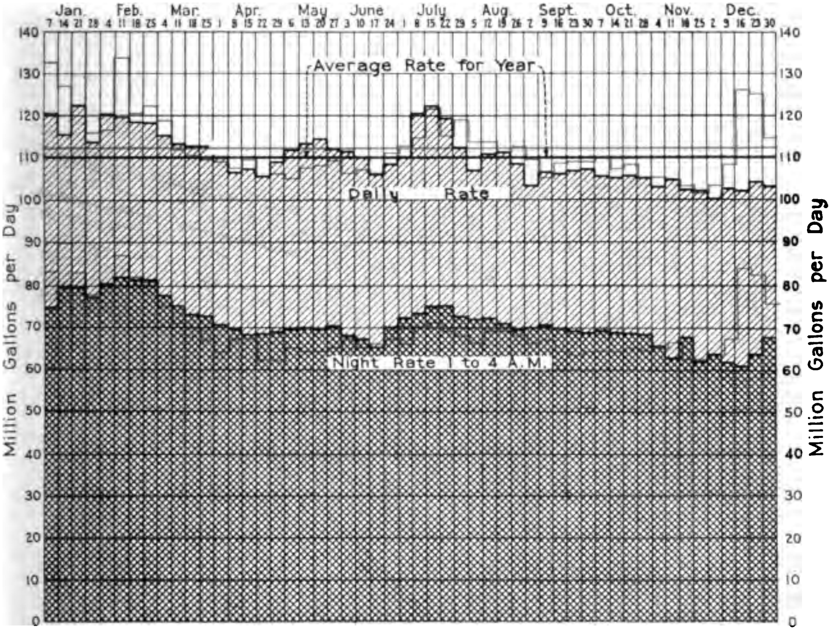
It will be noted that the low temperature during the months of January and December, 1910, as compared with the corresponding months in 1911, was coincident with a large increase in both the daily average and night rate of consumption. It is also noticeable that although the daily average was lower in 1911 than in 1910, the night rate has been larger during the greater portion of the past year than during the previous year. The fact that between the hours of 1 and 4 A.M. water is drawn from the mains at the rate of over 70,000,000 gallons in 24 hours is very strong proof that, notwithstanding the decrease in consumption, a large amount of preventable waste is still taking place.

Metering of Service Pipes.

The following table gives the statistics relative to the installation of water meters in the several cities and towns, in conformity with chapter 524 of the acts of 1907.

AVERAGE RATE OF CONSUMPTION
IN
METROPOLITAN WATER DISTRICT
AND
RAINFALL AND AVERAGE TEMPERATURE OF AIR AT CHESTNUT HILL RESERVOIR
FOR
EACH WEEK DURING 1911

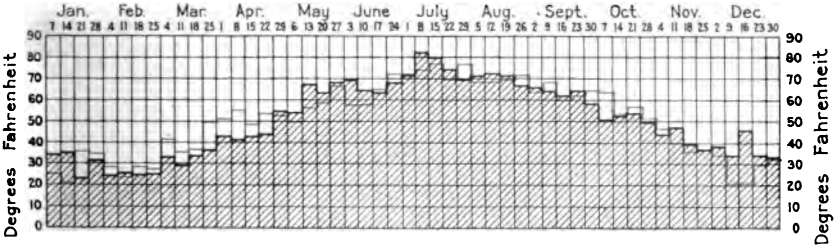
CONSUMPTION AND NIGHT RATE



RAINFALL IN INCHES

1.49	0.57	0.00	0.90	1.72	1.05	0.43	0.32	0.03	0.39	1.23	0.52	1.10	1.40	0.72	0.35	0.00	0.08	0.13	0.04	0.30	0.11	2.69	1.09	0.06	0.00	0.18	0.00	0.00	4.51	0.00	0.00	1.04	0.69	3.28	0.67	0.68	0.16	2.08	1.68	0.00	1.24	0.09	0.26	0.48	2.36	0.66	0.65	0.06	1.03	1.80	0.21

AVERAGE WEEKLY TEMPERATURE



Averages for 1910 shown in Red

City or Town.	Number of Meters required to be set on Old Services Each Year.	Meters set on Old Services.				New Services installed, 1911.[1]	New Services equipped with Meters, 1911.[1]	Services in Use December 31, 1911.	Meters in Use December 31, 1911.	Per Cent. of Services metered December 31, 1911.
		1908.	1909.	1910.	1911.					
Boston,	4,225	84	5,503	5,481	6,487	1,441	1,078	95,037	25,975	27.33
Somerville,	411	732	621	501	570	137	200	12,259	6,526	53.23
Malden,	14	43	62	8	2	197	175	7,632	7,314	95.83
Chelsea,	240	198	756	779	1,092	80	80	4,510	4,252	94.28
Everett,	252	338	255	277	285	159	92	5.466	1,560	28.54
Quincy,	230	358	33	423	1,680	444	487	7,746	4,801	61.98
Medford,	179	857	927	1,555	178	175	175	4,563	4,542	100.00
Melrose,	119	2,432	135	7	5	37	82	3,620	3,863	100.00
Revere,	138	85	184	110	176	208	200	3,610	1,261	34.93
Watertown,	-	-	-	-	-	114	60	2,156	2,130	100.00
Arlington,	55	108	56	63	127	141	121	2,181	1,536	70.43
Milton,	-	-	-	-	-	74	74	1,510	1,510	100.00
Winthrop,	100	213	975	706	6	84	95	2,553	2,487	100.00
Stoneham,	65	116	225	186	155	36	38	1,491	826	55.40
Belmont,	-	-	-	-	-	103	103	1,008	1,008	100.00
Lexington,	32	113	70	56	86	48	54	883	615	69.65
Nahant,	16	30	40	26	18	37	39	559	284	50.81
Swampscott,	21	264	142	28	13	66	66	1,535	1,535	100.00
Totals,	6,097	5,971	9,984	10,206	10,880	3,581	3,219	158,319	72,025	45.49

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[1] The number of new meters installed and the number of new services equipped with meters seldom agree exactly for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

All of the cities and towns in the District have set the number of meters required by the terms of the act, and nine municipalities had at the close of the year metered practically all of their service pipes. At the end of the year 45.49 per cent. of all the service pipes in the District were metered as compared with 37.56 per cent. at the beginning of the year.

WATER SUPPLIED OUTSIDE THE METROPOLITAN DISTRICT.

In addition to the quantity supplied to the cities and towns comprising the Metropolitan Water District, 1,260,625,200 gallons have been drawn from the Metropolitan Works for the supply of places outside the District, as follows: —

The United States Government Reservation on Peddock's Island has received a continuous supply equivalent to 89,300 gallons per day.

A small portion of the town of Saugus has been supplied with an average of 13,100 gallons per day through pipes of the town of Revere.

In consequence of the low level of the water in Crystal Lake, from which the town of Wakefield obtains its supply, 83,948,700 gallons were supplied to that town from the Metropolitan Works during the following periods: July 17 to 21 inclusive, August 10 to 17 inclusive, and August 22 to December 31 inclusive.

The town of Framingham has drawn 222,700,000 gallons from filter galleries located near Farm Pond on the Sudbury watershed, and 41,300,000 gallons from the Sudbury Aqueduct through a pipe crossing under Farm Pond.

For the use of the Westborough State Hospital, 53,053,000 gallons have been drawn from the open channel of the Wachusett Aqueduct. The supply to the hospital from this source was shut off from April 13 to May 18 inclusive, and on September 28 and 29, during which periods water was not flowing in the Wachusett Aqueduct.

The city of Worcester between August 1 and December 31 diverted 694,900,000 gallons from that portion of the Wachusett watershed which the city was in 1902 given the right to take for the purpose of a water supply; and between September 28 and October 21, the city diverted 64,900,000 gallons from the Wachusett watershed by pumping from Eagle Lake in Holden. Between October 24 and November 10, 62,440,000 gallons were drawn from the Wachusett Reservoir and pumped into the Worcester distributing mains.

The following table shows the quantities diverted and the amounts to be paid to the Metropolitan Water District for these quantities, with the exception of the sums to be paid on account of the diversion from Asnebumskit and Kendall Brooks and Eagle Lake, which have not yet been determined.

PLACE SUPPLIED.	Total Quantity (Gallons).	Average Daily Quantity (Gallons).	Dates on which Water was supplied.	Amounts charged for Water supplied.
Worcester: —				
From Eagle Lake,	64,900,000	177,800	Sept. 28 to Oct. 21,	. . .
From Asnebumskit Brook and Kendall Reservoir,	694,900,000	1,903,800	Aug. 1 to Dec. 31,	. . .
From Wachusett Reservoir,	62,440,000	171,100	Oct. 24 to Nov. 10, inc.,	$1,810 76
Westborough State Hospital,	53,053,000	145,300	Jan. 1 to Apr. 12, May 19 to Sept. 27, Sept. 30 to Dec. 31,	1,591 59
Framingham: —				
From Sudbury Aqueduct,	41,300,000	113,200	July 17,	991 20
From Farm Pond Galleries,	222,700,000	610,100		427 10
Wakefield,	83,948,700	230,000	July 6, July 17 to July 21, Aug. 10 to Aug. 17, Aug. 22 to Dec. 31,	5,876 40
Peddock's Island,	32,598,000	89,300	- -	2,036 32
Saugus,	4,785,500	13,100	- -	250 00
	1,260,625,200	3,453,700		

QUALITY OF THE WATER.

About forty per cent. of the water used in the Metropolitan District during the past year was drawn from the Sudbury and Cochituate sources. The proportion from these sources was much larger than in any year since 1898, and as a result the water drawn from the taps in the Metropolitan District has been of a higher color and has contained a larger proportion of ammonia and chlorine than in recent years.

The number of microscopic organisms present in the water has also been somewhat above the average, but there has been no growth of organisms of sufficient magnitude to cause objectionable tastes and odors in the water as drawn from the taps. Weekly microscopical and bacterial examinations have been made in the laboratory of the Board of the water from various parts of the works, and chemical examinations have been made by the State Board of Health, the results of which are given in tabular form in Appendix No. 2, Tables Nos. 28 to 34. There have been made 2,465 microscopical and 1,174 bacterial examinations of the water from various parts of the works, and results have been received of 397 chemical examinations made by the State Board of Health.

In the Wachusett Reservoir 195 units of Dinobryon were present in April, 140 units of Uroglena on May 1, 1,240 units of Anabæna on June 20, and 140 units of Uroglena on October 10. All of these growths were of short duration and not large enough to cause any trouble. The average color of the water was 0.08.

In the Sudbury Reservoir there was a growth of Synura from March 20 to May 1, with a maximum of 210 units on the latter date. Uroglena were present on May 8, but the growth lasted less than a week. There was a growth of Dinobryon during September and October which reached a maximum of 1,700 units in the latter part of September. None of these growths were of sufficient size to cause the water to have more than a very faint odor.

In Framingham Reservoir No. 3 Asterionella were present in March and April. On April 25, 5,780 units were observed. Chlamydomonas were present in small numbers from January 1 to the middle of May.

The waters of the Ashland and Hopkinton reservoirs have been of good quality and comparatively low in color. Hopkinton Reservoir contained a growth of about 500 units of Uroglena for two weeks in April.

Whitehall Reservoir contained a growth of Uroglena during April and a growth of Dinobryon during December, both of which caused the water to have a disagreeable taste and odor, but no water was being drawn from the reservoir during these periods.

There were no growths of objectionable organisms in Framingham Reservoir No. 2 during the year.

Growths of three objectionable organisms have been present in Lake Cochituate during the year. Chlamydomonas were present from January 1 until the middle of July, but did not affect the water drawn from near the surface after June 1. The largest number observed was 230 units on April 10. Dinobryon were observed in the latter part of July, but not in sufficient numbers to cause objectionable taste and odor until the early part of October, when 1,060 units caused the water to have a fishy odor when hot. This growth continued during October. During the period of summer stagnation a growth of Aphanizomenon developed at mid-depth in the lake, 11,520 units being observed on August 9. When the water in the lake overturned, in November, these organisms came to the surface and on reaching the consumers caused a few complaints to be received, not on account of the taste and odor, but because of a red scum which they caused on the hot water.

In the distributing reservoirs in the Metropolitan District there have been growths of Chlamydomonas, Dinobryon and Uroglena which have at times given a faint disagreeable odor to the water drawn from the taps, but the water has been generally of good quality and very few complaints have been received from the water takers.

A growth of Conferva, which attached itself to the bottom of the Bear Hill Reservoir, made its appearance in October and caused the water in that reservoir to have an objectionable appearance. The water was lowered about 4 feet and a portion of the growth removed.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1902 to 1911, inclusive: —

	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.
State Board of Health Examinations.										
Color (Nessler standard),	0.26	0.25	0.23[1]	0.24[1]	0.24[1]	0.22[1]	0.19[1]	0.18[1]	0.14[1]	0.25[1]
Total residue,	3.93	3.98	3.93	3.86	3.86	3.83	3.50	3.46	3.05	4.18
Loss on ignition,	1.56	1.50	1.59	1.59	1.39	1.40	1.35	1.43	1.24	1.66
Free ammonia,	0.0016	0.0013	0.0023	0.0020	0.0018	0.0013	0.0011	0.0011	0.0013	0.0015
Albuminoid ammonia, total,	0.0139	0.0125	0.0139	0.0145	0.0159	0.0129	0.0115	0.0128	0.0118	0.0156
Albuminoid ammonia, dissolved,	0.0119	0.0110	0.0121	0.0124	0.0134	0.0109	0.0092	0.0103	0.0102	0.0128
Albuminoid ammonia, suspended,	0.0020	0.0015	0.0018	0.0021	0.0025	0.0020	0.0024	0.0025	0.0016	0.0029
Chlorine,	0.29	0.30	0.34	0.35	0.34	0.33	0.33	0.28	0.28	0.38
Nitrogen as nitrates,	0.0092	0.0142	0.0110	0.0083	0.0054	0.0068	0.0092	0.0034	0.0030	0.0029
Nitrogen as nitrites,	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
Oxygen consumed,	0.40	0.39	0.37	0.35	0.36	0.32	0.26	0.25	0.22	0.33
Hardness,	1.3	1.5	1.5	1.4	1.3	1.3	1.2	1.3	1.1	1.4
Metropolitan Water and Sewerage Board Examinations.										
Color (platinum standard),	.33	.35	.32	.28	.25	.27	.22	.23	.18	.22
Turbidity.	2.3	2.2	2.4	1.9	2.2	2.2	2.4	2.6	2.1	2.2
Total organisms,	367	286	303	528	550	427	695	1,959	421	735
Amorphous matter,	34	36	36	37	42	47	64	97	72	76
Bacteria,	164	126	176	231	154	176	148	195	213	197

NOTE. — Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

[1] Platinum standard.

SANITARY INSPECTION.

All premises on the several watersheds have been inspected for the purpose of maintaining sanitary conditions that will protect from pollution the water supplied to the Metropolitan District. The results of these inspections are given in the following tables: —

Summary of Sanitary Inspections on the Wachusett Watershed in 1911.

DISTRICT.	Number of Premises inspected.[1]	CLASSIFICATION OF CASES INSPECTED.													CONDITION AT END OF YEAR.		WATER SUPPLY.		
		Cesspools dug before 1911.	Cesspools dug during 1911.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter Beds.	Satisfactory.	Unsatisfactory.	Premises having Public Water Supply.	Premises supplied by Private Wells, Cisterns, etc.	Premises on which no Water is used.
							Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.									
French Brook, . .	61	27	3	-	-	-	25	2	27	1	-	4	2	-	58	3	8	51	2
Muddy Brook, . .	37	13	1	-	-	-	19	-	22	-	-	-	-	1	37	-	-	37	-
Gates Brook, . . .	167	103	5	-	2	-	39	3	50	-	-	10	1	-	163	4	-	162	5
Malden Brook, . .	29	14	-	-	-	-	15	-	22	-	-	1	1	-	29	-	-	28	1
Chaffin Brook, . .	186	89	4	-	1	-	70	8	87	-	-	14	2	-	178	8	71	108	7
Asnebumskit Brook, .	281[2]	137	10	3	3	9	59	8	85	-	3	39	7	2	261	20	185	80	16
Muschopauge, . . .	88	22	-	-	1	1	48	2	42	1	-	10	1	-	84	4	5	78	5
South Wachusett Brook,	86	32	1	1	1	1	40	3	49	1	-	8	3	-	81	5	-	82	4
Trout Brook, . . .	34	4	-	-	-	-	25	1	26	-	1	2	-	-	32	2	-	33	1
East Wachusett Brook, .	207	80	-	2	-	3	107	5	105	3	-	14	2	1	195	12	-	197	10
Stillwater River, . .	142	53	-	-	-	-	75	2	75	2	-	8	3	1	139	3	-	136	6
Waushacum, . . .	166[3]	64	1	-	-	1	88	3	60	2	-	7	6	82	161	5	-	160	6
French Hill, . . .	31	19	1	-	-	-	9	-	12	-	-	1	1	-	31	-	-	30	1
Totals, . . .	1,515	657	26	6	8	15	619	37	662	10	4	118	29	87	1,449	66	269	1,182	64

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[1] On some premises there are two or more cases.

[2] Not including 11 summer cottages at Asnebumskit Pond.

[3] Not including 213 summer cottages at Waushacum Lakes.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1911.

DISTRICT.	Number of Premises inspected.[1]	CLASSIFICATION OF CASES INSPECTED.														CONDITION AT END OF YEAR.	
		Sewer Connections.	Cesspools dug before 1911.	Cesspools dug during 1911.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.
								Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.						
Sudbury Watershed.																	
Farm Pond,	280	259	10	3	-	1	-	-	-	17	-	-	5	7	-	279	1
Framingham Reservoir No. 3,	89	-	43	3	-	1	-	33	4	42	-	-	2	2	-	85	4
Stony Brook,	296	-	219	4	-	-	-	37	4	114	5	-	18	12	1	288	8
Angle Brook,	1,980	1,537	286	1	-	1	2	104	3	226	1	1	49	16	1,786	1,976	4
Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook,	312	-	180	7	-	-	-	95	2	97	-	-	19	6	-	310	2
Eastern Sudbury,	222	-	168	17	-	-	-	28	4	36	-	1	5	11	-	217	5
Indian Brook,	412	-	199	2	-	-	4	146	14	73	2	-	27	14	-	393	19
Western Sudbury,	184	-	87	-	-	1	-	66	11	67	-	1	7	9	-	172	12
Whitehall Reservoir,	113	-	29	-	-	1	-	63	2	37	-	-	11	5	-	111	2
Cedar Swamp,	800	518	170	1	-	1	-	56	21	133	-	-	38	14	-	779	21
Cochituate Watershed.																	
Snake Brook,	184	-	125	-	-	1	-	44	4	43	1	-	5	4	-	180	4
Pegan Brook,	983	685	219	9	-	-	2	48	-	93	-	1	4	10	945	983	-
Course Brook,	89	2	59	3	-	1	-	18	2	43	-	-	3	2	-	87	2
Beaver Dam Brook,	1,291	941	213	33	2	12	4	46	18	157	10	1	31	18	-	1,262	29
Totals,	7,235	3,942	2,007	83	2	20	12	784	89	1,178	19	5	224	130	2,732	7,122	113

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[1] On some premises there are two or more cases.

Under the heading "unsatisfactory" are included all cases where it is possible that under the most unfavorable conditions drainage from privies or sinks may reach a water course, all suspected cases and all cases of manufacturing wastes entering feeders, even though there may have been some attempt at previous purification.

The drainage system constructed during 1910 for the purpose of diverting from Lake Cochituate the surface drainage from an area of about 140 acres, on which there was in 1910 a resident population of 707, was placed in service on January 13, 1911, thus removing several cases of unsanitary drainage.

During the past year there has been a large growth in the industrial development of South Framingham, which has increased the growth of population, not only in that village but also in the adjoining towns of Natick, Sherborn, Ashland and Hopkinton. In South Framingham, 4 factories, 2 stores, 1 hall and buildings for the occupancy of 156 families have been erected and several more are under construction.

This building development has extended beyond the reach of the present sewer system in Framingham, and in some cases the new buildings are in locations where the sewage cannot be disposed of in cesspools without endangering the water supply. In the Lokerville section there are 140 houses from which the drainage cannot be taken into the existing sewer system, and at a recent town meeting the Sewer Commissioners of Framingham were instructed to make a study of the problem of providing sewerage for this area, as well as for the area near the State Muster Field, known locally as Hastingsville. It is desirable that sewers should be provided in this section in order to prevent the pollution of the Metropolitan Supply.

During the past year a public water supply has been introduced in the town of Ashland. The supply is drawn from driven wells located near the Sudbury River, above the Dwight mill pond, and is pumped to a concrete standpipe built on a hill off Myrtle Street. The water is distributed through 6.5 miles of 6-inch, 8-inch and 12-inch pipe to 224 houses. Although the soil throughout the village is generally gravelly, it is probable that the increased use of water in the town will tend to increase the danger of polluting the water of Framingham Reservoir No. 2.

The New York, New Haven & Hartford Railroad Co. has maintained a camp for laborers on the shores of Farm Pond, and early in the year complaints were made that the conditions at the camp were not sanitary. Although the water from Farm Pond has not been used for the supply of the Metropolitan District for many years, the Railroad Company, at our request, dug a cesspool, cut and burned brush and trimmed trees in the vicinity of the camp, and stationed a watchman there to enforce sanitary regulations.

In the cities and towns on the Sudbury and Cochituate watersheds, which have systems of sewerage conveying the sewage outside the watersheds, the number of premises connected with sewers has been increased by 132, and the number existing on streets where sewers have been built has been reduced from 150 to 127. The number in the several places on December 31, 1911, was as follows: —

	PREMISES CONNECTED WITH SEWERS.		PREMISES NOT CONNECTED WITH SEWERS.	
	1910.	1911.	1910.	1911.
Marlborough,	1,522	1,537	83	71
Westborough,	510	518	25	19
Framingham,	1,116	1,197	9	5
Natick,	656	685	33	32
Sherborn,	6	5	-	-
Totals,	3,810	3,942	150	127

Nine cases of typhoid fever were reported from the Wachusett watershed, 7 of which were in Holden and 2 in Princeton. Four of the Holden cases were from one family in January, and the others occurred in May, September and October, in Holden Centre, Bryantville and Dawson. The 2 cases in Princeton were at Buck's Mill in August, and were closely connected. Thirty-three cases were reported on the Sudbury and Cochituate watersheds, 18 of which occurred in houses connected with the public sewers which convey house drainage outside the watershed. Ten of the cases were reported from Natick, 1 from Wayland, 11 from Framingham, 2 from Ashland, 2 from Southborough, 6 from Marlborough and 1 from Westborough. Seven of the cases in Natick were apparently caused by an infected milk supply. Four of the cases in Framingham occurred in one house, just at the close of the year. In all cases the premises were visited and precautions taken to prevent the spread of the disease or the pollution of the water supply.

Swamp Ditches and Brooks.

The ditches draining swamps on the several watersheds, having an aggregate length of 36.36 miles, have been cleaned as usual and the weeds and brush mowed and burned for a width of from 10 to 20 feet on both sides of the ditches. Ditches in Crane Swamp, in Marlborough and Northborough, and in Swamp No. 76, in Sterling, were repaired for a length of 1.78 miles where the side slopes had been injured by cattle. The wire fencing on the property line around Big Crane Swamp was repaired for a distance of 7,000 feet by setting new chestnut posts and restringing the wires, and new Wheelock wire fence 844 feet long erected on the property line between land of the Board and J. A. McHale on the westerly side of the Big Crane Swamp.

Observations have been made of the colors of the waters of the brooks draining the swamps which have been improved by ditching as follows: —

SWAMP.	Area of Watershed (Acres).	Area of Swamp (Acres).	Length of Ditches (Feet).	Colors of Waters (Platinum Standard).						
				BEFORE DRAINING.		AFTER DRAINING.				
				Averages for Years 1894, 1895, 1899.	Averages for Years 1900, 1901, 1902.	1907.	1908.	1909.	1910.	1911.
Crane, . .	1,856	460	45,250	1.95	-	.77	.72	.64	.65	.60
No. 54, . .	750	72	8,930	-	.90	.53	.41	.33	.36	.44
No. 55, . .	1,625	220	27,661	-	1.27	.80[1]	.44	.36	.38	.47
No. 76, . .	225	26	6,173	-	.44	.27	.24	.20	.21	.29

[1] Nearly one-half of the ditches in Swamp No. 55 were not built until 1907.

Protection of the Supply by Filtration.

The filter-beds which are maintained for the purpose of purifying the surface water collected from thickly populated districts before its admission to the storage reservoirs have been cared for as usual.

The filter-beds, having an area of 14 acres, which receive and filter the water from about 1.8 square miles of the thickly settled portion of the city of Marlborough, received and cared for the entire flow of the brook during the year. The 17 artificial beds were cleaned in June and again in September and October; the 8 natural beds were thoroughly cleaned in June and the weeds were cut in September and October.

The reservoir and filter-bed on Farm Street, in Framingham, received diluted sewage from the overflow of the Marlborough main sewer on two days in March, two days in April and one day in December, and there was a flow of ground water upon the bed at times during March, April, May, November and December.

At the Pegan Brook pumping station, where the surface drainage from an area of about 1 square mile in the thickly settled portion of Natick is pumped upon filter-beds before entering Lake Cochituate, the pumps were operated 193 days during the year and 220,939,000 gallons were pumped, equivalent to a daily average of 605,310 gallons. The quantity of coal used was 152,230 pounds and 1,451 gallons were pumped per pound of coal. The cost of operating the pumping station, cleaning the filter-beds and caring for the grounds was $2,731.18, making the cost per million gallons filtered $12.36.

The water flowing from an area of 225 acres, in which is included the more thickly settled portion of the town of Sterling, has been filtered on 4 filter-beds, having an area of 2 acres, before entering Waushacum Pond on the Wachusett watershed.

The Gates Terrace filter-beds, at Sterling Junction, on which is received the drainage from a few summer cottages, were operated from April 22 to October 31.

The filter-beds on which is received the drainage from the Worcester County Training School have received the usual attention and have satisfactorily cared for the sewage of that institution.

FORESTRY.

During the past year trees and shrubs have been planted as follows: —

On the Wachusett watershed 30 acres of land on shallow flowage fills, in drained swamps and intervale lands were planted with 12-inch to 24-inch arbor vitæ seedlings spaced 6 feet apart in both directions, and 12.5 acres of land east of the South Dike in Clinton, where pines planted in 1908 had been destroyed by fire, were replanted with 3-year-old pine seedlings. The area occupied by the Flagg nursery and by nearly all of the Lamson nursery has also been planted with white pines.

Three thousand white pines were set out along the line of the Weston Aqueduct, at Edgell Street near the Nobscot Station, near gaging-chamber No. 2 and near siphon-chamber No. 2.

The necessary care has been given to the Lamson and Oakdale nurseries. At the close of the year the Lamson nursery contained 2,200 arbor vitæ seedlings from 12 inches to 18 inches high, and the Oakdale nursery, which was started in 1910, contained 2,000 2-year-old white pine transplants, 22,800 2-year-old white pine seedlings and 28,700 1-year-old white pine seedlings.

On the Wachusett watershed the undesirable trees and brush have been cut on 55 acres of land planted with pines, and an improvement thinning has been made on 55 acres of land on which there is a growth of trees from 20 to 40 years old. The gross cost of the work on both of these areas was $2,362.31, but as $983.61 were received for fence posts, railroad ties and cordwood sold, the net cost of the improvement was $1,378.70.

Exclusive of the lands submerged by the Wachusett Reservoir, the Board now owns about 4,500 acres of land on the Wachusett watershed, of which about 1,800 acres were forested when acquired, 1,350 acres have been planted, 520 acres remain to be planted and 830 acres are not available for planting.

The protection of the trees from the ravages of destructive insects has necessitated the expenditure of $7,062.21, as follows: —

Spot Pond,	$2,954 40
Mystic Lake,	46 24
Chestnut Hill Reservoir,	655 89
Weston Reservoir and Aqueduct,	1,178 18
Sudbury and Cochituate Aqueducts,	275 58
Lake Cochituate,	131 00
Sudbury Reservoir,	149 98
Framingham Reservoirs, Nos. 1, 2 and 3,	30 00
Wachusett Reservoir and Aqueduct,	1,640 94
	$7,062 21

In addition to the above, $1,266.50 was expended for the purchase from the Fitzhenry-Guptill Company of a power sprayer consisting of a U-shaped tank, having a capacity of 400 gallons, a 4-cylinder, 4-cycle, 10-horse-power gasoline engine, and a 3½-inch x 3¾-inch phosphor bronze triplex pump, all mounted on a platform wagon.

The work of spraying is done with this machine much more efficiently and economically than by the method previously used, in which the power was furnished by tanks of gas under high pressure.

At Spot Pond 55 acres were sprayed between May 26 and June 3, using 1,840 pounds of arsenate of lead. About 950 pounds of tanglefoot and 69 gallons of creosote mixture were also used on the trees.

At the Weston Reservoir and along the Weston Aqueduct about 24 acres were sprayed. Work at this reservoir was much increased for the reason that the adjacent property owners have done but little to suppress the moths.

The number of both brown-tail and gypsy moths on the land controlled by the Board has increased, particularly in the vicinity of the Sudbury and Wachusett reservoirs, where the area of woodland is large. The oak trees in the vicinity of the North Dike at the Wachusett Reservoir are badly infested with brown-tail moths, and 71 acres of this land were sprayed with arsenate of lead. All of the young pines on both the Sudbury and Wachusett works have been inspected twice during the year, and shoots infested with the pine-tree weevil have been cut off and burned. The number of infested shoots was less than during the previous year.

Late in the year it was discovered that chestnut trees near the Wachusett Dam were infected with the Chestnut Bark Disease, which has destroyed all or nearly all of this species of tree on a large area in New Jersey, Pennsylvania and New York. Trees affected by this disease have been found in the towns of Marlborough, Northborough, Clinton, Boylston, Sterling, West Boylston and Holden, and it is feared that it may be necessary to cut all chestnut trees on the property of the Board.

One result of the severe drought during the spring months was a large number of forest fires on the watersheds, several of which caused much damage to the tree growth. The most serious fire occurred on May 10 and burned over 211 acres belonging to the

Board, 103 acres of which were pasture land; 59 acres were covered with a growth of 10 and 12 year old white pine seedlings and 49 acres with hard wood timber from 15 to 40 years old. This fire was caused by a spark from a locomotive on the Boston & Maine Railroad and the Railroad Company reimbursed the Board for the damage to the amount of $3,000.

The total number of fires reported on the Wachusett watershed was 21 and the area burned over 330 acres. The total estimated damage was $3,985.78, and the amount received from railroad companies in reimbursements for fires caused by locomotives was $3,136.90. The number of pine trees destroyed by the fires was about 47,000. Seven fires occurred on the Sudbury Works, burning over 45⅓ acres, but most of the fires occurred on pasture land and the loss was not large.

Seven fires occurred on the grounds at Spot Pond, burning over 11.34 acres and destroying 250 small white pines.

From January 1 until February 11 about 6 men were employed cutting into cordwood the trees in Crane Swamp which were felled by fires which occurred in September and October, 1910. Two hundred and eleven cords of wood were cut and this, with the remaining standing wood on 105 acres, most of which was killed by the fire, was sold to E. W. Wheeler & Son of Berlin, Mass., for $1,367.50.

DISTRIBUTING RESERVOIRS.

Weston Reservoir.

The reservoir and its connected structures are in good order. In addition to the regular work of caring for the grounds and buildings, cleaning the screens and open channel, painting fences and tool houses and destroying moths, the attendant and three men employed at the reservoir have constructed a footpath alongside the aqueduct from Newton Street to the screen-chamber, a distance of 1,550 feet.

Chestnut Hill Reservoir.

The grounds and structures are in good condition, with the exception of the wooden fence on the line of Beacon Street, which should be replaced during the coming year. The exterior woodwork of the upper, intermediate and lower gate-houses has been given two coats of paint. Considerable time has been spent in removing water grasses from the shallow parts of the reservoir, especially from the Lawrence Basin, where the growth appears to increase from year to year.

Waban Hill Reservoir.

The exterior and interior woodwork of the gate-house has received two coats of paint and the embankments were given a dressing of stable manure.

Forbes Hill Reservoir and Standpipe.

The standpipe was in service throughout the year except from September 13 to October 14, while the upper floor of the tower was being renewed. The granolithic surface of the upper floor, which had become badly cracked, was removed, together with the underlying cinder concrete which was disintegrated. The granolithic was broken into pieces about 1 inch in diameter and then mixed with small stones and so used as a foundation on which was placed a layer of felt covered with a 2-inch layer of Portland cement concrete mixed in the proportion of 1 part of cement, 2 of sand and 4 of pebbles. Upon this foundation, which was prepared by the maintenance department, the Simpson Brothers Corporation placed a layer of Neuchatel rock asphalt 1 inch in thickness, reinforced with corrugated steel. A 6-inch fillet of asphalt was placed next the outer wall of the tower. The cost of the work was $718.83. The granolithic walk around the reservoir has been repaired by relaying four of the concrete blocks and by digging out and grouting the smaller cracks. Some repairs were made to the concrete lining of the reservoir.

Mystic Reservoir.

This reservoir has been in continuous use throughout the year.

Mystic Lake and Pumping Station.

Mystic Lake has not been used as a source of water supply since January 1, 1898, and the machinery at the pumping station has not been operated since that date. The house occupied by the Superintendent of Pipe Lines and Reservoirs, which is located near the pumping station building, together with the barn and stable on the same grounds, have received two coats of paint and minor repairs. A new floor has been laid on the bridge over the outlet at the Lake.

Arlington Standpipe.

The standpipe was out of service from November 15 to December 14, during which time it was cleaned, the exterior given two coats of white lead and oil, and the interior one coat of red lead and two coats of Gilsonite paint. The work was done by F. A. Tibbetts, of Malden, at a cost of $475.

Spot Pond.

A foreman and 8 men have cared for the grounds and buildings around the pond, cleaned the shores, resurfaced the paths and patrolled the grounds for the purpose of protecting the property of the Board and preventing the pollution of the water.

Fells and Bear Hill Reservoirs.

These reservoirs have been in service throughout the year.

PIPE YARDS.

At both the Chestnut Hill and Glenwood pipe yards the buildings are in good condition. The railroad siding at the Glenwood pipe yard has been repaired at a cost of $113.75, and that at the Chestnut Hill yard at a cost of $220.68. Concrete bins, having a capacity of about 70 cubic yards, have been built at the Glenwood yard for the storage of sand and stone used in repairing streets. A watchman's clock with five stations has been installed at the Glenwood yard.

PIPE LINES.

The length of pipes owned and operated by the Metropolitan Water and Sewerage Board was increased by 4.56 miles during the year, making a total on December 31, 1911, of 101.58 miles. The length of mains 4 inches in diameter and larger connected with the works but owned and operated by the several cities and towns supplied with water, is 1,569.92 miles.

The most important work done during the past year in connection with the maintenance of the pipe lines has been the changes made necessary by the abolishment of the crossing at grade of Webster Avenue and the Fitchburg Railroad in Somerville. This work necessitated the raising of 983 feet of 48-inch pipe and the laying of 256 feet of 48-inch pipe on a temporary timber foundation and on a bridge over the railroad. The method adopted for raising the pipes was as follows: — Spruce piles were driven on each side of the pipe at intervals of 6 feet, and alternate bents of the piles were capped with 6-inch x 12-inch girder caps set at the elevation of the surface of the regraded street. The pipes were raised by the use of screws 2½ inches in diameter and 6 feet long, suspended from the girder caps and connected with the pipes by means of wire ropes and chains. After the pipes were raised to the required height they were supported on 12-inch x 12-inch caps placed at intervals of 6 feet for the whole length of the raised portion of the main. The pipes were raised about 17 feet at the crossing of the railroad, where the pipes are now supported on a bridge located alongside and east of the roadway bridge. The pipe bridge consists of two plate girders 78 feet long, 6 feet high, placed 11 feet apart, with a wooden floor and cover forming a box in which are laid the Metropolitan Water Works 48-inch main and the 20-inch main of the city of Somerville. In connection with this work it was necessary to relocate a 36-inch valve and a 20-inch connection with the Somerville pipe system, on which there was a Venturi meter. The work was begun in May, the 48-inch main was cut and emptied preparatory to being raised on June 13, and the main was again placed in service on July 8.

The cost of the work has been paid by the Boston & Maine Railroad in connection with other charges for the abolishment of the grade crossing, and the necessary excavation, together with the construction of the trestle and pipe bridge, was done by the contractors for the Railroad Company. The Metropolitan Water Works furnished the pipe, superintended the work and supplied the skilled labor required for raising and relocating the pipes. The cost of pipes and special castings furnished by this department was $2,259.25 and of labor and other expenses $4,250.01. The total cost of the work connected with the raising and relocation of the pipe, including the portion of the work done by the Railroad Company, was $15,616.42.

Between November, 1910, and March, 1911, a new and enlarged channel for Stony Brook was constructed at Morton Street, in West Roxbury. For the permanent support of the 36-inch water main which crosses over the channel at this point three masonry piers, spaced 17 feet on centres, were built up from the conduit and the pipes are now supported on hard pine blocks placed on top of these piers.

There have been 43 leaks on the Metropolitan water mains, none of which have been of a serious character or have caused damage to private property by flooding. Thirty-six of the leaks were due to defective joints and 14 of these occurred at wooden joints, which have been used in place of lead to prevent electrolytic action on the pipes. The total cost of repairing all leaks was $1,528.90, of which amount $708.57 was incurred in repairing two leaks at joints on pipes under the Mystic and Malden rivers, where the services of a diver were required.

A 48-inch pipe in the line which is used in conveying water from the Chestnut Hill Reservoir to the wells in the pumping stations was found to be cracked for its entire length, due to settlement of the pipe until at one point it rested on a boulder. The leakage from this break was very small as there was but little pressure on the pipe. The cost of substituting a new pipe was $191.76.

The steelwork of the bridge which supports the 20-inch water main over the Boston & Albany Railroad at St. James Street, in Newton, has been scraped, the bare spots given a coat of red lead, and all the steelwork given one coat of Smith's Durable Metal Compound. The woodwork of the bridge was given one coat of white lead and oil. The cost of this work was $134.35.

The bridge which supports the 48-inch and 20-inch pipes over the Boston & Maine Railroad at College Avenue, in Medford, has been treated in the same manner. Sheet lead was also placed under the steel girders where they are exposed to the blast of gases from locomotives. The cost of repairing this bridge was $384.84.

The upper surface of the roof or cover of the bridge which supports the 48-inch and 20-inch mains over the Mystic River in Medford, is used as a foot path by the public, and the wood surface, which was worn, has been replaced by a layer of Neuchatel asphalt about 1 inch in thickness.

Metering of Water to Municipalities.

There were 65 Venturi meters, in sizes varying from 6 inches to 60 inches, connected with the Metropolitan water mains on December 31, 1911, of which 52 were in use in measuring the water supplied to the several municipalities in the Metropolitan District. There were also 4 Hersey disc meters, 1 Hersey torrent, 3 Hersey detector, 2 Crown and 3 Union rotary meters, which were used to measure the water supplied in districts where the flow was too small to be conveniently or properly measured with a Venturi meter. All of these meters have been read and inspected twice each week, and all necessary repairs made by a regular force of two men with an occasional assistant. The interior surfaces of the steel chambers in which the meters are placed have been scraped and painted.

Pressure Regulators and Recording Gages.

No change has been made during the year in the number or location of the pressure regulators used to control the pressure in the mains in the District. The 19 pressure recording gages connected with the distribution system have been in constant use and the average elevations of the water, due to the pressure in the mains, is given in Appendix No. 2, Table No. 44.

Electrolysis.

A complete electrical survey of the Metropolitan water mains was made during January, February and March, to determine the difference of potential between the pipes and electric railway tracks and the electric currents flowing over the pipes. At several places the conditions shown by the survey differed from the conditions determined from the previous complete survey, made during the summer of 1908; and in general, while the differences of potential have increased somewhat, the current flows have decreased, which would seem to indicate a higher soil resistance during the winter of 1911 than during the summer of 1908. The results also show that the installation of wooden insulating joints on our pipe lines constructed since 1908 has prevented an increase in the electric currents flowing on the pipe system, which would otherwise have resulted from the construction of the new mains.

Features which seem to require special consideration are: The development of a large positive area on the low service pipe lines near Coolidge Corner in Brookline, due to the operation of a new sub-station on Webster Street since the middle of November; the development of a small positive area in the vicinity of Salem Street and Fellsway West, in Medford, which has gradually been developing since the power station was put in operation at this place in August, 1906; an increase in the positive area near Washington Square in Chelsea; a very large increase in the negative potential at Boylston Street near Chestnut Hill Avenue in Brookline; and a noticeable increase in negative potentials and electric currents on the supply pipe lines in Newton.

The electrical conditions on the remainder of the system are substantially the same as have existed for the past few years.

CLINTON SEWERAGE.

Pumping Station.

The Clinton sewage-disposal works were operated daily throughout the year. The average daily quantity of sewage pumped to the filter-beds was 829,000 gallons. The sewerage system of the town was extended quite materially during the year, but there was no increase in the quantity of sewage, due probably to the low rainfall.

The following are statistics relating to the operation of the pumping station: —

Daily average quantity of sewage pumped (gallons),	829,000
Daily average quantity of coal consumed (pounds),	1,380
Gallons pumped per pound of coal,	600
Number of days pumping,	365
Cost of pumping: —	
Labor,	$1,715 34
Fuel,	1,104 88
Repairs and supplies,	194 63
Total for station,	$3,014 85
Cost per million gallons pumped,	$9 97
Cost per million gallons raised 1 foot high,	0.201

About ¾ of an acre of land, comprising lawns and grass land about the pumping station was graded and seeded down in the spring.

Filter-beds.

The sewage was applied to the filter-beds in practically the same manner as during the preceding 3½ years. The beds were used in rotation throughout the year. Each of the 25 one-acre beds has received about 59,600 gallons of sewage in 30 minutes about once in two days.

The sludge collected in the 8 settling basins, amounting to 724 cubic yards, has been used on grass lands belonging to the Board at the filter-beds and on the rear slope of the westerly portion of the North Dike.

The results of the analysis of the sewage and effluent are given in the following table: —

[Parts per 100,000.]

	1906.	1907.	1908.	1909.	Average of Four Years, 1906-09.	1910.	1911.
Albuminoid ammonia, sewage,	.8558	.8442	.5735	.7425	.754	.7050	1.0683
Albuminoid ammonia, effluent,	.0955	.0744	.0554	.0819	.0768	.0686	.0639
Per cent. removed,	89	91	90	89	89.7	90.3	94
Oxygen consumed, sewage,	9.84	7.87	3.43	7.04	7.045	6.658	9.3292
Oxygen consumed, effluent,	1.34	1.07	0.765	1.165	1.085	.8863	.8713
Per cent. removed,	86	87	78	83	83.5	86.7	91
Free ammonia, sewage,	3.5650	3.8342	4.6193	4.6283	4.1617	3.8867	5.7417
Free ammonia, effluent,	1.2723	1.3176	1.3722	1.2917	1.3134	.6493	.7369
Per cent. removed,	64	66	70	70	67.5	83.3	87
Nitrogen as nitrates, effluent,	.1445	.1664	.1468	.2319	.1724	.7338	.9740
Iron, effluent,	2.1042	2.2454	1.8100	1.7633	1.9807	.6395	.5203

The improvement in the effluent effected by the construction of additional underdrains and the placing of distributors on the beds to secure a uniform distribution of sewage, is very plainly shown by the figures in the above table. The increase in the nitrogen in the form of nitrates and the reduction in the amount of iron which has been accomplished during the past two years, and especially during the past year, as compared with the results during the years 1906 to 1909, furnish conclusive evidence of the material improvement which has been effected. The cost of maintaining the filter-beds has been as follows: —

Labor,	$3,702 75
Supplies and expenses,	94 77
Total,	$3,797 52
Cost per million gallons treated,	12 63

The cost per million gallons treated was $1.39 greater than for the previous year, due largely to an increase in the rates paid to laborers.

ENGINEERING.

In addition to the routine work in connection with the supervision of the maintenance and operation of the works, the engineering force has completed a survey of Framingham Reservoir No. 2, showing property of the Commonwealth, and has partially completed a similar survey of Framingham Reservoir No. 1. Levels have been taken by means of which the capacity of Lake Cochituate is to be accurately determined for the upper ten feet of its depth. An estimate has been prepared of the cost of works designed for filtering the water drawn from Lake Cochituate.

Appended to this report are tables giving the amount of work done and other information relative to contracts, a series of tables relating to the maintenance of the Metropolitan Water Works, including the rainfall, yield of sources of supply, consumption of water in the different districts, the number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for the year 1911.

Respectfully submitted,

DEXTER BRACKETT,
Chief Engineer.

BOSTON, Jan. 1, 1912.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

Gentlemen: — The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1911.

Organization.

The engineering organization during the year has been as follows: —

Division Engineers:

Frederick D. Smith, .	*In charge of maintenance and construction, South Metropolitan System.*
Frank I. Capen, . .	*In charge of maintenance and construction, North Metropolitan System.*
Henry T. Stiff, . .	*In charge of office and drafting room.*

In addition to the above, the average number of engineering and other assistants employed during the year was 10, which includes 1 assistant engineer, 3 instrumentmen, 2 inspectors, 2 draftsmen and 2 stenographers.

METROPOLITAN SEWERAGE DISTRICTS.

Areas and Populations.

During the year no changes have been made in the extent of the sewerage districts as given in the last annual report.

The populations of the district, as given in the following table, are based on the census of 1910.

Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1911.

	CITY OR TOWN.	Area (Square Miles).		Estimated Population.	
North Metropolitan District.	Arlington,	5.20		11,910	
	Belmont,	4.66		5,960	
	Boston (portions of),	3.45		104,450	
	Cambridge,	6.11		107,320	
	Chelsea,	2.24		34,180	
	Everett,	3.34		35,510	
	Lexington,[1]	5.11		4,160	
	Malden,	5.07		46,310	
	Medford,	8.35		24,490	
	Melrose,	3.73		16,210	
	Revere,	5.86		19,610	
	Somerville,	3.96		80,220	
	Stoneham,	5.50		7,480	
	Wakefield,	7.65		11,810	
	Winchester,	5.95		9,700	
	Winthrop,	1.61		10,860	
	Woburn,	12.71		15,690	
			90.50		545,870
South Metropolitan District.	Boston (portions of),	20.39		189,690	
	Brookline,	6.81		29,210	
	Dedham,[1]	9.40		9,480	
	Hyde Park,	4.57		16,090	
	Milton,	12.59		8,220	
	Newton,	16.88		41,330	
	Quincy,	12.56		34,200	
	Waltham,	13.63		28,840	
	Watertown,	4.04		13,520	
			100.87		370,580
	Totals,		191.37		916,450

[1] Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

During the year additions by purchase or otherwise have been made within the sewerage districts, so that there are now 103.336 miles of Metropolitan sewers. Of this total, 9.642 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 93.694 miles of Metropolitan sewers and other works having been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system: —

North Metropolitan System.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1911.	Special Connections.	
				Character or Location of Connection.	Number in Operation.
Boston: —					
Deer Island,	6′ 3″ to 9′,	1.367	4	– –	–
East Boston,	9′ to 1′,	5.467	24	Shoe factory,	1
Charlestown,	6′ 7″ ×7′ 5″ to 1′,	3.292	14	Navy Yard,	8
				Almshouse,	1
Winthrop,	9′,	2.864	12	Club House,	1
				Fire Dept. Station,	1
				Private Building,	1
Chelsea,	8′ 4″×9′ 2″ to 1′ 10″×2′ 4″,	5.123	10	Bakery,	1
				Rendering works,	1
				Metropolitan Water Works blow-off,	1
				Chelsea Water Works blow-off,	2
Everett,	8′ 2″×8′ 10″ to 4′ 8″×5′ 1″,	2.925	6	Metropolitan Water Works blow-off,	1
				Cameron Appliance Co.,	1
				Shultz-Goodwin Co.,	1
				Andrews-Wasgatt Co.,	1
				National Metallic Bed Co.,	1
				Linoide Co.,	1
Malden,	4′ 6″×4′ 10″ to 1′,	5.844[1]	30	Metropolitan Water Works blow-off,	1
				Private buildings,	158
Melrose,	4′ 6″×4′ 10″ to 10″,	6.099[2]	36	Private buildings,	111
				Factory,	1
				Railroad station,	1
Cambridge,	5′ 2″×5′ 9″ to 1′ 3″,	7.167	37	Slaughter house,	1
				City Hospital,	2
				Street Railway Machine Shop,	1
Somerville,	6′ 5″×7′ 2″ to 1′ 10″×2′ 3″,	3.471	10	Tannery,	1
				Slaughter-houses (3),	1
				Car-house,	1
				Street railway power house,	1
				Stable,	1
				Rendering works,	1
Medford,	4′ 8″×5′ 1″ to 10″,	5.359	22	Armory building,	1
				Private buildings,	8
				Stable,	1
				Police sub-station,	1
Winchester,	2′ 11″×3′ 3″ to 1′ 3″,	6.428	13	Tannery,	4
				Private buildings,	2
				Gelatine factory,	1
				Stable,	1
				Railroad station,	1
Stoneham,	1′ 3″ to 10″,	0.010	4	– –	–
Woburn,	1′ 10″×2′ 4″ to 1′ 3″,	0.933	3	Glue factory,	1
Arlington,	1′ 6″ to 10″,	3.520[3]	35	Private buildings,	132
				Railroad station,	1
				Car-house,	3
				Post Office,	1
Belmont,[4]	– –	–	3	– –	–
Wakefield,[4]	– –	–	1	– –	–
Revere,	4′ to 3′,	0.048	2	– –	–
		59.917[5]	266		464

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[1] Includes 1.84 of a mile of sewer purchased from the city of Malden.

[2] Includes .736 of a mile of sewer purchased from the city of Melrose.

[3] Includes 2.631 miles of sewer purchased from the town of Arlington.

[4] The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.

[5] Includes 2.787 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

South Metropolitan System.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1911.	Special Connections.	
				Character or Location of Connection.	Number in Operation.
Boston (Back Bay),	6′ 6″ to 3′ 9″,	1.500[1]	13	Tufts Medical School, Private house, Administration Building, Boston Park Department, Simmons College buildings, Art Museum,	1 1 1 1 2
Boston (Brighton),	5′ 9″ ×6′ 0″ to 12″,	6.010[2]	14	Abattoir,	3
Boston (Dorchester).	3′×4′ to 2′ 6″×2′ 7″,	2.870[3]	12	Chocolate works, Machine shop, Paper mill, Private buildings,	2 1 1 2
Boston (Roxbury),	6′ 6″×7″, 4′ 0″,	1.430	–	– –	–
Boston (West Roxbury).	9′ 3″×10′ 2″ to 12″,	7.600	12	Parental school, Lutheran Evangelical Church, Private buildings,	1 1 4
Brookline,	6′ 6″×7′ 0″ to 8″,	2.540[4]	12	– –	–
Dedham,	4′×4′ 1″ to 3′ 9″×3′ 10″,	2.350	6	– –	–
Hull,	60″ pipe,	0.750	–	– –	–
Hyde Park,	10′ 7″×11′ 7″ to 4′×4′ 1″,	4.527	17	Mattapan Paper Mills, Private buildings,	1 2
Milton,	11′×12′ to 8″,	3.600	18	Private buildings,	2
Newton,	4′ 2″×4′ 9″ to 1′ 3″,	2.911	6	Private houses,	2
Quincy,	11′ 3″×12′ 6″ to 24″ pipe,	6.580	12	– –	–
Waltham,	3′ 6″×4′,	0.001	1	– –	–
Watertown,	4′ 2″×4′ 9″ to 12″,	0.750[5]	5	Factories, Stanley Motor Carriage Co., Knights of Pythias Building,	2 1 1
		43.419	128		32

[1] Includes .355 of a mile of sewer purchased from the city of Boston.

[2] Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also, .026 of a mile of sewer purchased from the town of Watertown.

[3] Includes 1.24 miles of sewer purchased from the city of Boston.

[4] Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.

[5] Includes .025 of a mile of sewer purchased from the town of Watertown.

COST OF CONSTRUCTION.

[To December 31, 1911.]

The cost of the 103.336 miles of Metropolitan sewers enumerated above, including six pumping stations, screen-house, electric lifting station, siphons and appertaining structures, may be summarized as follows: —

North Metropolitan System,	$6,686,891 50
South Metropolitan System,	8,813,232 53
	$15,500,124 03

Information relating to areas, populations, local sewer connections and other data for the whole Metropolitan Sewerage District appear in the following table: —

North Metropolitan District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	CONNECTIONS MADE WITH METROPOLITAN SEWERS.	
					Public.	Special.
90.50	545,870	683.05	480,600	88.0	266	464

South Metropolitan District.

100.87	370,580	557.52	241,865	65.3	128	32

Entire Metropolitan District.

191.37	916,450	1,240.57	722,465	78.8	394	496

Of the estimated gross population of 916,450 on December 31, 1911, 722,465, representing 78.8 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,240.57 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan System by 394 public and 496 special connections. It appears, also, that there has been during the year an increase of 29.25 miles of local sewers connected with the Metropolitan System, and that 14 public and 25 special connections have been added.

PUMPING STATIONS AND PUMPAGE.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with the corresponding volumes for the previous year.

Tables for estimating flows in main sewers below the East Boston and Charlestown pumping stations were prepared about the year 1900, when the sewers were comparatively new and the surfaces smooth, and have been used in engine house computations since that date. These sewers have now become more or less covered with slime and the flow somewhat retarded.

Recently a Venturi meter has been installed at Deer Island for measuring the sewage flow. In connection with tests of the new engines at the Deer Island and East Boston pumping stations, observations have been made on present sewage flows in these sewers by the Venturi meter and otherwise. As a result of these later observations, deductions from the earlier ratings of the sewers have been made, 7 per cent. for the East Boston station and 6 per cent. for the Charlestown station.

The tables of pumping in this report have been prepared from the last ratings of sewage flows in the main sewers, as above outlined.

PUMPING STATION.	AVERAGE DAILY PUMPAGE.			
	Jan. 1, 1910, to Dec. 31, 1910.	Jan. 1, 1911, to Dec. 31, 1911.	Decrease during the Year.	
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	59,000,000	52,800,000	6,200,000	10.5
East Boston,	57,000,000	50,800,000	6,200,000	10.9
Charlestown,	34,300,000	32,600,000	1,700,000	5.0
Alewife Brook,	3,585,000	3,012,000	573,000	16.0
Quincy,	4,132,000	4,069,000	63,000	1.5
Ward Street (actual gallons pumped),	22,900,000	22,600,000	300,000	1.3

CONSTRUCTION.

NORTH METROPOLITAN SYSTEM.

EAST BOSTON STATION.

The construction provided for in Chapters 556 and 582 of the Legislative Acts of 1908 for repairs and extensions to the East Boston pumping station, including new engine, boiler and coal houses and wharf, with an additional engine, boilers, piping and connections, has been practically completed during the year.

The contracts for the building and wharf were completed at the time of the last report and were described in that report. The reinforced concrete floor of the wharf has been placed during the year by day labor under the direction of the engineer. Concrete reinforcement around some of the piles has also been constructed by day labor. The remaining piles will be reinforced from time to time by the maintenance labor during coming years. The wharf deck was completed in condition for use in the middle of September.

The work of erecting the 100,000,000-gallon centrifugal pump and engine was commenced about January 1, 1911, and the pump was in condition to operate in April. It was put into the regular service of the station September 25, 1911. The official test on this engine was made December 1, 1911.

The six vertical boilers erected under contract with the Robb-Mumford Boiler Company were first put into service July 15.

The valves for piping were furnished by the Walworth Manufacturing Company and the Crane Company.

On March 15, a contract was made with the Lumsden & Van Stone Company for furnishing and erecting all main piping in the new boiler room and new and old engine rooms and basement of new engine room. This work was completed on August 19.

The piping and boilers were covered by the Philip Carey Company. This work was completed September 30. A tile floor in the new engine room has been placed during the year by maintenance labor, together with granolithic sidewalk in front of the station. The six old boilers and old economizer have been removed. The old boiler room has been rearranged by new partitions for office, toilet and work rooms. There remain to be completed some renewals and rearrangement of screens and screen-house, and this matter is still under consideration by the Board.

STABLE AND LOCKER BUILDING.

The reinforced concrete locker building, described in the last report, was completed about June 1. The fitting of the building, including plumbing, wiring, piping for heating, stalls, etc., was done by the maintenance labor. The building was completed ready for occupancy about September 1. The cost of the building was $14,166.75, and the sum of $4,524.40 was paid on account of the land, making a total of $18,691.15 expended for this purpose.

TEST OF EAST BOSTON ENGINE.

The tests of the 100,000,000-gallon engine and centrifugal pump at East Boston, specified in the contract with the Allis-Chalmers Company, were carried out December 1, 1911. The tests were made under the direction of Frank I. Capen, Division Engineer, and William M. Francis, Mechanical Engineer, for the Metropolitan Sewerage Works, and J. R. Belknap, Mechanical Engineer for the Allis-Chalmers Company.

The engine, pump and connecting piping were furnished by the

Allis-Chalmers Company, of Milwaukee, Wis., under a contract dated June 5, 1909.

The pump and engine were erected between December, 1910, and April, 1911, and were first operated in June, 1911. By agreement between the Board and the Allis-Chalmers Company, they have been operated in the regular service of the station since September 25, 1911, and prior to official test and acceptance by the Board.

The following table contains principal dimensions of engine and pump: —

Principal Dimensions of Engine and Pump.

Diameter H. P. cylinder (inches),	18
Diameter I. P. cylinder (inches),	32
Diameter L. P. cylinder (inches),	46
Stroke of pistons (inches),	30
Diameter of suction (inches),	60
Diameter of discharge (inches),	60
Revolutions per minute,	89.3 to 106.1

Contract Requirements.

The contract for the engine contained requirements as follows: —

The capacity must equal 100,000,000 United States gallons of sewage per twenty-four hours when lifting vertically 19 feet, the quantity of sewage to be determined by measurements in the discharge sewer at points below the station selected by the Engineer. The actual head against which the pump is acting is to be measured every fifteen minutes by a mercury or other approved gauge, at a point near the pump end of the discharge channel. The elevations in the suction channel are to be taken every fifteen minutes by a gauge in the manhole near the easterly end of the station. The duty of the engine and pump guaranteed by the contractor is 96,500,000 foot pounds for each 1,000 pounds of commercially dry steam delivered by the Board at the throttle valve of the engine. In this test steam containing less than one and one-half per cent. of entrained water, as determined by calorimeter measurements, is to be considered as commercially dry steam. The duration of the test is to be twelve hours. The sewage is to be screened and to consist of about two-thirds ordinary domestic sewage and about one-third of sea water introduced into the sewer at convenient points. The engine and pump are to be operated continuously during the twelve hours of the trial under the conditions before outlined and steam supplied shall not have more than 125 pounds pressure per square inch at the throttle valve. The official trial of the engine and pump is to be conducted jointly by the Engineer and a representative of the contractor, and if the duty determined by this trial shall be less than that guaranteed by the contractor, the sum of five hundred dollars ($500) for each one million foot-pounds below the guaranteed duty and pro rata for fractional parts, shall be deducted from the price bid by the contractor. If the duty shown by the official trial shall be ten per cent. less than that guaranteed in the contract, the Board may reject the engine and pump.

Trial.

The capacity of the engine to lift 19 feet when pumping at a rate of 100,000,000 gallons per 24 hours was established during the official duty test of December 1, and during wet and stormy weather of the period of probation when the engine was run in the regular service of the house prior to formal test and acceptance, as noted above.

To obtain sufficient water for the duty test of December 1, tide water was introduced into the sewer through tide gates at Malden River and at Chelsea Creek. The fluctuating head of the tide gave a varying supply of water to the pump, at times above 100,000,000 gallons per day and at times below 100,000,000 gallons per day. The normal lift of sewage at the station approximates 16 feet. The losses of head through the connecting channels credited to the pump by terms of the contract, were found by trial to approximate 2 feet for a discharge of 100,000,000 gallons per 24 hours. The lift contemplated in the contract during duty test was therefore 18 feet. Steam was furnished for the test by two boilers excluded from other service of the station and conveyed to the engine through one of the 8-inch steam lines excluded from other service. The feed water was weighed in barrels and pumped through an economizer to the boilers by an auxiliary pump on the engine. Quarter-hour records of pressure gauges and other apparatus used in connection with the test were made. The head pumped against was determined by a water column near the pump end of the discharge channel. Elevations of sewage in the suction chamber were measured by means of a hook gauge at a manhole near the pumping station. The quantity of sewage pumped was determined by meter measurements of the sewage flow in the main sewer about 1,000 feet below the East Boston pumping station. Calorimeter measurements to determine the moisture of steam were made at intervals of fifteen minutes.

The observers were employés of the Metropolitan Water and Sewerage Board.

Trial Data and Results.

Date of trial,	December 1, 1911.
Duration of trial,	12 hours.

Average Pressure.

Steam at throttle (pounds),	126.03
First receiver (pounds),	23.60
Second receiver (pounds),	7.02
Vacuum (inches of mercury),	26.68

Head pumped against.

Average elevation of sewage in discharge sewer,	109.02
Average elevation of sewage in discharge channel, including losses in discharge tube and appurtenances,	111.08
Average elevation of sewage in suction,	91.71
Average lift credited to pump in contract,	19.37
Minimum lift pumped against,	18.33
Maximum lift pumped against,	20.27

Revolutions.

Total revolutions during test,	72,585.00
Average revolutions per minute,	100.81

Useful Work performed by Engine.

Total water pumped (United States gallons per twenty-four hours),	93,900,000

Water fed to Boilers.

Total water weighed (pounds),	72,232.50
Deduct leakage from boilers, pipes, valves and wastes from calorimeter,	2,533.38
Total steam chargeable to engine,	69,699.00
Average entrainment of moisture in steam entering engine in excess of 1½ per cent. (average entrainment 1⅛ per cent.),	0.00
Total dry steam used by engine (pounds),	69,699.00

Duty.

Duty in foot pounds per 1,000 pounds commercially dry steam corrected for losses,	109,000,000
Duty in foot pounds per 1,000 pounds water fed to boilers,	105,200,000

Horse Power and Efficiency.

Average indicated horse power,	472.20
Average water horse power,	319.81
Efficiency per cent.,	67.73
Water per indicated horse power per hour (pounds),	12.30

The work of the engine during the test slightly exceeded the work specified in the contract. The duty developed by the engine during its test of 109,000,000 foot pounds of work for each 1,000 pounds of commercially dry steam used exceeds the duty of 96,500,000 foot pounds guaranteed by the engine builders in their contract by 13 per cent.

SECTIONS 65 AND 66. — MALDEN AND EVERETT EXTENSION.

Chapter 547 of the Acts of 1910 authorized the Board to purchase of the City of Malden an existing city sewer in Eastern Avenue extending from the Metropolitan sewer in Bryant Street to Broadway, and to construct a new sewer in Broadway from Eastern Avenue to the Everett city line. The Board and the City of Malden did not come to an agreement during the year 1910 about the purchase of the city sewer. The Legislature of 1911 repealed chapter 547 of 1910 and by chapter 512 of the Acts of 1911 again authorized the Board to purchase the existing city sewer and construct a new sewer in Broadway, as above outlined.

The city sewer in Eastern Avenue was purchased on June 16, 1911, having the following lengths and sizes of sewer: —

30-inch brick sewer,	3,066 linear feet.
24-inch brick sewer,	1,433 linear feet.
Total length,	4,499 linear feet.

This length of city sewer purchased is known as Section 65 and the new 18-inch and 12-inch pipe sewer constructed by the Board in Broadway to the Everett city line as Section 66 of the North

Metropolitan Sewerage System. The new sewer provides specially for the sanitary drainage of about 80 acres in the northeasterly portion of Malden in the vicinity of Broadway, and about 80 acres in the northwesterly section of Everett.

The construction of the new sewer in Broadway was carried out by Antonio G. Tomasello and is described in detail below: —

Contract 81, Section 66. — Malden and Everett Extension.

Division Engineer in Charge. — FRANK I. CAPEN.
Contractor. — ANTONIO G. TOMASELLO, Boston, Mass.

This contract involved the construction of 2,520 lin. ft. of 18-inch pipe sewer and 112 lin. ft. of 12-inch pipe sewer extending from the city sewer purchased of Malden and beginning at the junction of Eastern Avenue and Broadway, extending southerly through Broadway to the Everett city line at a point about 100 feet southerly from Grover Street, a total distance of 2,632 lin. ft.

For 200 feet near Eastern Avenue the excavation was in wet sand and gravel to clay near the sewer location. For 650 feet to near Sheafe Street the excavation was largely through rock, with sand and gravel above the rock. For 1,350 feet, the excavation was through very fine and very wet sand. For about 300 feet near the end of the section, the excavation was in dry sand, gravel and clay. For a length of about 600 feet near Sheafe Street, largely through the rock section, the excavation was carried out by bucket excavating machinery. For the remainder of the section, excavation was carried out without the aid of machinery.

The construction was commenced June 19, 1911, and completed December 6, 1911. About 438 cu. yds. of rock were excavated. The sewer was built of Akron pipe reinforced with about 6 inches of concrete. The average depth of the excavation was 15 feet, varying from a minimum of 10 feet to a maximum of 23 feet. When the sewer was at a greater depth than 9 feet below the surface, 6-inch pipe chimneys, reinforced with concrete, were built.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 stations and 103.336 miles of Metropolitan sewers, receiving the discharge from 1,240.57 miles of town and city sewers at 396 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 165 men includes 108 engineers and other employés at the pumping stations, and 57 men employed on actual sewer maintenance and care of pumping station grounds. In the following two tables the use of the completed systems and other data are shown: —

NORTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1911.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.[1]	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Deer Island), .	0.70	Separate, . . .	–	–	1,207[2]	1,207[2]	–	–	100.0	–
Winthrop, . . .	30.22	Separate, . . .	2,507	4.25	10,655	10,860	1.30	1.61	98.1	80.7
Boston (East Boston), .	30.68	Separate and combined,	4,673	12.50	58,413	61,250	1.08	2.18	95.4	49.5
Chelsea, ...	29.39[3]	Separate and combined,	3,589[4]	9.00	32,300	34,180	1.10	2.24	94.5	49.1
Everett, ...	44.75	Separate and combined,	4,434	6.60	29,265	35,510	1.92	3.34	82.4	57.5
Malden, ...	57.89	Separate, . . .	5,834	6.20	36,170	46,310	2.91	5.07	78.0	57.4
Melrose, ...	36.38	Separate, . . .	2,861	4.60	13,160	16,210	1.77	3.73	81.2	47.5
Boston (Charlestown), .	21.16	Separate and combined,	5,298	7.85	41,590	41,993	0.67	1.27	99.0	52.8
Cambridge, . . .	145.44	Separate and combined,	15,562	6.80	105,820	107,320	5.01	6.11	98.6	82.0
Somerville, . . .	95.38	Separate and combined,	14,502	5.45	79,035	80,220	3.35	3.96	98.5	84.6
Medford, . . .	54.35	Separate, . . .	4,175	5.75	24,005	24,490	2.91	8.35	98.0	34.9
Winchester, . . .	24.77	Separate, . . .	1,328	5.40	7,170	9,700	1.25	5.95	73.9	21.0
Woburn, . . .	14.35[5]	Separate, . . .	1,083	5.70	6,175	15,690	0.96	12.71	39.4	7.6
Stoneham, . . .	12.60	Separate, . . .	783	4.90	3,835	7,480	0.66	5.50	51.3	12.0
Arlington, . . .	24.24	Separate, . . .	1,360	6.10	8,295	11,910	1.74	5.20	69.7	33.5
Belmont, . . .	14.32	Separate, . . .	647	6.40	4,665[6]	5,960	1.09	4.66	78.3	23.4
Wakefield, . . .	12.23	Separate, . . .	595	5.60	3,330	11,810	0.48	7.65	28.2	6.3
Lexington,[7] . . .	–	– –	–	–	–	4,160	–	5.11	–	–
Revere, ...	34.20	Separate, . . .	2,629	5.90	15,510	19,610	1.81	5.86	79.1	30.9
Totals, . . .	683.05	– –	71,860	6.70	480,600	545,870	30.01	90.50	88.0	33.2

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[1] Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1911, and the population from census of 1910.

[2] Estimated by Superintendent James H. Cronin of the Institution on Deer Island.

[3] The districts connecting at Cypress Street, Revere Beach Parkway, Springvale Avenue, Willoughby, Bellingham, Highland, Hawthorn and Spruce streets are now contributing sewage.

[4] Estimated.

[5] Exclusive of Mystic River valley sewer and tanneries.

[6] Including 2 connections with McLean Hospital, having an estimated population of 525.

[7] Lexington not connected.

SOUTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1911.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.[1]	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Back Bay), .	24.78	Separate and combined,	1,629	17.00	27,695	28,230	1.24	1.61	98.1	77.0
Boston (Brighton), .	57.49	Separate and combined,	3,090	6.30	19,465	28,460	3.17	3.74	68.4	84.8
Brookline, . . .	66.32	Separate and combined,	3,803	7.35	27,950	29,210	3.46	6.81	95.7	50.8
Newton, . . .	112.43	Separate, . . .	6,046	6.00	36,275	41,330	7.22	16.88	87.8	42.8
Watertown, . . .	36.24	Separate, . . .	1,920	5.40	10,370	13,520	1.97	4.04	76.7	48.8
Waltham, . . .	43.41	Separate, . . .	3,505	7.65	26,815	28,840	2.23	13.63	93.0	16.4
Boston (Dorchester), .	50.93	Separate and combined,	4,874	7.70	37,530	62,500	2.37	4.89	60.0	48.5
Milton, ...	10.40	Separate and combined,	522	5.20	2,715	8,220	0.66	12.59	33.0	5.2
Hyde Park, . . .	26.90	Separate, . . .	1,804	7.20[2]	13,000	16,090	1.31	4.57	80.8	28.7
Dedham, . . .	15.63	Separate, . . .	591	5.20	3,075	9,480[3]	0.78	9.40	82.4	8.3
Boston (Roxbury), .	-	- -	-	-	-	41,100	-	1.23	-	-
Boston (West Roxbury),	49.39	Separate and combined,	2,963	5.80	18,270[4]	29,400	2.32	8.92	62.1	26.0
Quincy, ...	63.60	Separate, . . .	3,668	5.10	18,705	34,200	2.92	12.56	54.7	23.2
Totals, . . .	557.52	- -	34,415	7.00	241,865	370,580	29.65	100.87	65.3	29.4

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[1] Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1911, and the population from census of 1910.

[2] Estimated by Town Engineer.

[4] Including connection with Institution at Austin Farm, having an estimated population of 1,083.

[3] Part of town not included in Metropolitan Sewerage District.

CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan sewerage stations: —

NORTH METROPOLITAN SYSTEM.

Deer Island Pumping Station.

At this station are four submerged centrifugal pumps with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.
Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 52,600,000 foot-pounds.
Average quantity raised each day: 52,800,000 gallons.
Force employed: 4 engineers, 1 relief engineer, 4 firemen, 3 oilers, 3 screenmen, 1 relief screenman and 1 laborer.
Coal used: Georges Creek, Pocahontas and New River, costing from $3.92 to $4.109 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	1,536,500,000	49,600,000	37,500,000	81,200,000	10.80	46,000,000
February,	1,457,000,000	52,100,000	40,500,000	85,100,000	10.88	43,200,000
March,	1,708,800,000	55,200,000	41,800,000	80,400,000	10.28	50,300,000
April,	1,760,500,000	58,700,000	46,700,000	97,400,000	11.14	55,100,000
May,	1,409,000,000	45,500,000	38,800,000	51,500,000	10.53	50,200,000
June,	1,665,300,000	55,600,000	48,700,000	87,200,000	11.26	58,700,000
July,	1,648,100,000	53,200,000	40,500,000	83,000,000	10.67	59,500,000
August,	1,614,200,000	52,100,000	42,200,000	93,700,000	11.43	62,900,000
September,	1,472,100,000	49,100,000	38,900,000	68,400,000	11.07	48,300,000
October,	1,531,200,000	49,400,000	39,200,000	71,000,000	10.62	46,500,000
November,	1,633,000,000	54,400,000	36,800,000	83,300,000	11.19	52,300,000
December,	1,821,400,000	58,800,000	42,500,000	103,000,000	11.50	58,200,000
Total,	19,257,100,000	-	-	-	-	-
Average,	-	52,800,000	41,200,000	82,100,000	10.95	52,600,000

East Boston Pumping Station.

At this station are four submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons with 19-foot lift.
Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 62,100,000 foot-pounds.
Average quantity raised each day: 50,800,000 gallons.
Force employed: 4 engineers, 2 relief engineers, 4 firemen, 1 relief fireman, 3 oilers, 3 screenmen, 1 relief screenman, 3 helpers, and 1 laborer.
Coal used: New River, costing from $3.735 to $4.10 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	1,478,900,000	47,600,000	35,600,000	79,300,000	15.33	54,900,000
February,	1,405,000,000	50,100,000	38,700,000	83,200,000	15.32	56,500,000
March,	1,651,100,000	53,200,000	39,900,000	78,600,000	15.53	58,400,000
April,	1,704,700,000	56,700,000	44,800,000	95,500,000	15.71	64,300,000
May,	1,351,400,000	43,500,000	37,000,000	49,700,000	15.47	66,800,000
June,	1,609,500,000	53,600,000	46,900,000	85,400,000	15.38	66,900,000
July,	1,590,400,000	51,200,000	38,700,000	81,200,000	15.46	53,400,000
August,	1,556,500,000	50,100,000	40,400,000	91,900,000	15.40	56,500,000
September,	1,416,300,000	47,100,000	37,000,000	66,500,000	15.60	67,200,000
October,	1,473,500,000	47,400,000	37,300,000	69,100,000	15.54	69,100,000
November,	1,577,200,000	52,400,000	35,000,000	81,500,000	15.69	63,800,000
December,	1,763,700,000	56,900,000	40,600,000	101,100,000	15.90	67,800,000
Total,	18,578,200,000	-	-	-	-	-
Average,	-	50,800,000	39,300,000	80,300,000	15.53	62,100,000

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one, 60,000,000 gallons, with 8-foot lift.

Average duty for the year: 55,600,000 foot-pounds.

Average quantity raised each day: 32,600,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from $3.685 to $3.90 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	960,900,000	31,000,000	22,700,000	45,500,000	8.29	49,800,000
February,	948,800,000	33,900,000	25,300,000	52,400,000	8.36	53,200,000
March,	1,030,300,000	33,200,000	26,100,000	47,800,000	8.39	52,300,000
April,	1,008,000,000	33,600,000	25,700,000	56,700,000	8.40	56,500,000
May,	914,700,000	29,500,000	24,200,000	32,100,000	8.15	55,700,000
June,	996,900,000	33,200,000	26,200,000	49,000,000	8.28	58,200,000
July,	1,018,700,000	32,900,000	24,500,000	63,100,000	8.21	54,600,000
August,	1,070,300,000	34,500,000	26,400,000	55,600,000	8.34	60,400,000
September,	984,900,000	32,800,000	25,300,000	39,900,000	8.36	59,100,000
October,	918,300,000	29,600,000	23,300,000	42,800,000	8.06	52,500,000
November,	1,043,400,000	34,800,000	24,300,000	52,300,000	8.32	60,200,000
December,	1,014,100,000	32,700,000	21,800,000	65,400,000	8.38	54,500,000
Total,	11,909,300,000	-	-	-	-	-
Average,	-	32,600,000	24,700,000	50,200,000	8.30	55,600,000

Alewife Brook Pumping Station.

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.*, two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.

Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.

Average duty for the year: 16,900,000 foot-pounds.

Average quantity raised each day: 3,012,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen, and 1 relief screenman.

Coal used: New River and Pocahontas, costing from $4.365 to $4.55 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	94,417,000	3,046,000	2,414,000	5,170,000	12.97	16,900,000
February,	97,352,000	3,477,000	2,598,000	5,494,000	12.42	16,400,000
March,	107,291,000	3,461,000	2,550,000	5,668,000	12.27	16,600,000
April,	123,105,000	4,103,000	3,380,000	6,076,000	12.54	19,900,000
May,	84,643,000	2,730,000	2,246,000	3,574,000	13.05	18,000,000
June,	75,152,000	2,505,000	2,203,000	4,615,000	12.97	16,800,000
July,	68,067,000	2,196,000	1,783,000	4,738,000	12.89	15,400,000
August,	71,647,000	2,311,000	1,700,000	4,983,000	12.88	15,700,000
September,	73,277,000	2,443,000	2,036,000	3,079,000	12.94	16,200,000
October,	84,008,000	2,710,000	2,330,000	3,814,000	12.93	16,000,000
November,	91,530,000	3,051,000	2,203,000	4,922,000	12.83	16,300,000
December,	127,373,000	4,109,000	3,380,000	7,580,000	12.55	18,400,000
Total,	1,097,862,000	-	-	-	-	-
Average,	-	3,012,000	2,402,000	4,976,000	12.77	16,900,000

South Metropolitan System.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of pumps: two, 50,000,000 gallons each, with 45-foot lift.

Average duty for the year: 79,400,000 foot-pounds.

Average quantity raised each day: 22,600,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 4 oilers, 4 assistant engineers, 1 machinist and 1 laborer.

Coal used: New River, costing from $3.527 to $4.26 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January, ...	634,200,000	20,500,000	16,600,000	28,000,000	39.74	74,600,000
February, . . .	685,900,000	24,500,000	18,500,000	38,900,000	40.70	86,800,000
March, ...	697,400,000	22,500,000	17,600,000	32,400,000	40.90	79,600,000
April, ...	769,000,000	25,600,000	20,500,000	38,100,000	41.38	86,100,000
May, ...	617,200,000	19,900,000	17,000,000	22,600,000	40.61	78,300,000
June, ...	651,900,000	21,700,000	16,000,000	35,900,000	39.80	82,200,000
July, ...	607,300,000	19,600,000	15,400,000	42,200,000	39.48	77,700,000
August, ...	595,300,000	19,200,000	15,900,000	33,300,000	39.89	75,900,000
September, . . .	631,600,000	21,100,000	17,100,000	27,300,000	40.01	76,300,000
October, ...	734,200,000	23,700,000	19,900,000	28,900,000	40.09	71,200,000
November, . . .	748,200,000	24,900,000	19,200,000	34,800,000	40.52	79,700,000
December, . . .	856,100,000	27,600,000	21,400,000	47,400,000	40.58	84,000,000
Total, . . .	8,228,300,000	-	-	-	-	-
Average, . . .	-	22,600,000	17,900,000	34,100,000	40.31	79,400,000

Records from plunger displacement.

Average slip for the year about 14.7 per cent.

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of pumps: 3,000,000 Deane; 5,000,000 Deane; 10,000,000 Lawrence centrifugal.
Average duty for the year: 32,942,000 foot-pounds.
Average quantity raised each day: 4,069,000 gallons.
Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.
Coal used: Cumberland, costing from $4.40 to $4.54 per gross ton.
Materials intercepted at screen during year, 183 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	128,350,000	4,140,000	3,680,000	5,600,000	21.19	30,000,000
February,	118,755,000	4,241,000	3,635,000	5,500,000	21.19	30,100,000
March,	131,325,000	4,236,000	3,770,000	4,790,000	21.11	30,100,000
April,	147,955,000	4,932,000	4,250,000	5,670,000	21.77	35,700,000
May,	119,645,000	3,860,000	3,330,000	4,610,000	21.21	34,400,000
June,	105,512,000	3,517,000	3,100,000	4,145,000	21.18	32,100,000
July,	101,904,000	3,287,000	2,825,000	4,140,000	21.12	31,600,000
August,	106,120,000	3,423,000	3,000,000	4,560,000	21.09	33,000,000
September,	120,190,000	4,006,000	3,550,000	5,430,000	21.01	33,600,000
October,	116,130,000	3,746,000	3,345,000	4,200,000	20.95	33,500,000
November,	130,105,000	4,337,000	3,310,000	5,640,000	21.19	35,300,000
December,	158,140,000	5,101,000	4,440,000	6,020,000	21.89	35,900,000
Total,	1,484,131,000	-	-	-	-	-
Average,	-	4,069,000	3,529,000	5,025,000	21.24	32,942,000

Nut Island Screen-house.

The plant at this house includes two sets of screens in duplicate, actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat and light for the house and burn materials intercepted at the screens, and furnish power for the Quincy sewage lifting station.

Average quantity of sewage passing screens daily, 42,000,000 gallons.
Total materials intercepted at screens during the past year, 1,101.96 cubic yards.
Materials intercepted per million gallons of sewage discharged, 1.94 cubic feet.
Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.
Coal used: New River and Cumberland, costing from $4.05 to $5.50 per gross ton.

COST OF PUMPING.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of six pumping stations are shown in detail: Chapter 494, Acts of 1911, "the Eight-hour Law," so called, has involved extra labor at all stations, increasing the average costs of labor in the tables of averages below.

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (19,257.1 Million Gallons) × Lift (10.95 Feet) = 210,865 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$12,993 40	$0.06162
Coal,	9,436 69	.04475
Oil,	272 51	.00129
Waste,	96 42	.00046
Water,	1,951 73	.00926
Packing,	206 99	.00098
Miscellaneous supplies and renewals,	854 21	.00405
Totals,	$25,811.95	$0.12241
Labor at screens,	-	.01357

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (18,578.2 Million Gallons) × Lift (15.53 Feet) = 288,529 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$17,024 60	$0.05900
Coal,	11,058 33	.03833
Oil,	348 79	.00121
Waste,	107 59	.00037
Water,	1,981 20	.00687
Packing,	123 61	.00043
Miscellaneous supplies and renewals,	1,043 24	.00361
Totals,	$31,687 36	$0.10982
Labor at screens,	-	.00990

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (11,909.3 Million Gallons) × Lift (8.30 Feet) = 98,847 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$11,864 57	$0.12003
Coal,	3,440 42	.03481
Oil,	194 75	.00197
Waste,	80 93	.00082
Water,	475 20	.00481
Packing,	63 53	.00064
Miscellaneous supplies and renewals,	677 48	.00685
Totals,	$16,796 88	$0.16993
Labor at screens,	-	.02991

Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.

Volume (1,097.86 Million Gallons) × Lift (12.77 Feet) = 14,019.7 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$5,998 79	$0.42788
Coal,	1,509 44	.10767
Oil,	145 84	.01040
Waste,	66 73	.00476
Water,	320 20	.02284
Packing,	15 11	.00108
Miscellaneous supplies and renewals,	192 64	.01374
Totals,	$8,248 75	$0.58837
Labor at screens, oiling and miscellaneous services,	-	.13356

Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.

Volume (8,228.3 Million Gallons) × Lift (40.31 Feet) = 331,683 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$14,874 51	$0.04484
Coal,	7,708 00	.02323
Oil,	217 74	.00066
Waste,	30 58	.00009
Water,	1,441 20	.00435
Packing,	91 64	.00028
Miscellaneous supplies and renewals,	1,796 60	.00542
Totals,	$26,160 27	$0.07887
Labor at screens,	-	.01317

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,484.1 Million Gallons) × Lift (21.24 Feet) = 31,522.3 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$5,428 58	$0.17221
Coal,	1,608 48	.05103
Oil,	39 73	.00126
Waste,	18 82	.00060
Water,	211 17	.00670
Packing,	3 41	.00010
Miscellaneous supplies and renewals,	377 19	.01197
Totals,	$7,687 38	$0.24387
Labor at screens, oiling and miscellaneous services,	-	.04949

Coal for use at the several stations has been purchased as follows: —

	Gross Tons, Bituminous Coal.							Price per Gross Ton.[1]
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen-house.	
Staples Coal Company,	-	-	-	-	106.990	-	-	$3 527
New England Coal and Coke Company.	-	-	484.08	-	-	-	-	3 69
New England Coal and Coke Company.	-	1,334.385	-	-	-	-	-	3 73
Staples Coal Company,	-	-	-	-	138.647	-	-	3 74
New England Coal and Coke Company.	-	-	310.56	-	-	-	-	3 857
New England Coal and Coke Company.	-	-	284.60	-	-	-	-	3 90
Staples Coal Company,	-	-	-	-	295.730	-	-	3 90
Staples Coal Company,	1,258	-	-	-	-	-	-	3 92
Staples Coal Company,	-	-	-	-	138.589	-	-	3 93
Staples Coal Company,	-	-	-	-	-	-	370.000	4 054
New England Coal and Coke Company.	-	1,859.495	-	-	-	-	-	4 087
Metropolitan Coal Company,	1,038	-	-	-	-	-	-	4 109
Metropolitan Coal Company,	-	-	-	-	-	-	200.000	4 20
Staples Coal Company,	-	-	-	-	1,141.578	-	-	4 26
New England Coal and Coke Company.	-	-	-	135.435	-	-	-	4 365
Neponset Coal Company,	-	-	-	-	-	31.609	-	4 394
Frost Coal Company,	-	-	-	-	-	79.986	-	4 40
Frost Coal Company,	-	-	-	-	-	46.616	-	4 45
Neponset Coal Company,	-	-	-	-	-	43.486	-	4 48
Frost Coal Company,	-	-	-	-	-	100.890	-	4 49
New England Coal and Coke Company.	-	-	-	51.167	-	-	-	4 525
Neponset Coal Company,	-	-	-	-	-	90.605	-	4 54
New England Coal and Coke Company.	-	-	-	144.549	-	-	-	4 55
J. F. Sheppard & Sons,	-	-	-	-	-	-	14.925	5 50
Total gross tons,	2,296	3,193.88	1,079.24	331.151	1,821.534	393.192	584.925	-
Average price per gross ton,	$4 007	$3 938	$3 79	$4 47	$4 094	$4 47	$4 14	-

[1] Includes adjustments for quality.

DRAINAGE FROM TANNERIES, GELATINE AND GLUE WORKS IN WINCHESTER, WOBURN AND STONEHAM.

Five men and a foreman have been employed during the whole of the present year, the same as last year, in flushing and cleaning the

Metropolitan sewers through the tannery districts of Winchester, Woburn and Stoneham.

All of the tanneries and glue works of the district now have settling tanks of substantial size. Beggs & Cobb Company of Winchester have three duplicate sets. The present tanneries have a combined capacity of 5,900 hides per day. At the date of this report, they were handling about 2,850 hides per day. Two of the larger tanneries were closed during the year.

Table No. 1 gives details of settling tanks introduced to date and indicates that during the year about 6,500 cubic yards of semi-liquid sludge were removed from the tanks. A measurement over weirs of manufacturing wastes from large establishments in this district was made about the end of the year and indicates, as outlined in Table No. 2, that the quantity of manufacturing drainage this year does not exceed that recorded last year.

No. 1. — *Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.*

LOCATION OF BASIN.	Basin put in Operation.	Inside Measurement of Basin (Feet).	Number of Times cleaned during Year to Jan. 1, 1912.	Average Quantity Semi-fluid Sludge removed (Cubic Yards).	Total Quantity Semi-fluid Sludge removed to Jan. 1, 1912 (Cubic Yards).
Beggs & Cobb Company, Basin No. 1, .	Jan. 15, 1910	47.0 × 23.0	15½	121	1,875
Beggs & Cobb Company, Basin No. 2, .	May 9, 1910	47.0 × 23.0	5	115	575
Beggs & Cobb Company, Basin No. 3, .	Oct. 19, 1911	51.0 × 25.0	1	122	122
American Hide and Leather Company, Factory E.	Aug. 1, 1910	48.3 × 23.0	7	98	686
American Hide and Leather Company, Factory D.	Nov. 15, 1910	48.0 × 23.1	None	-	-
Cottle Leather Company, ...	July 15, 1910	49.0 × 23.2	2	86	172
B. F. Kimball & Co., ...	Dec. 10, 1910	47.2 × 23.0	4	121	484
E. Cummings Leather Company, . .	Nov. 1, 1910	45.9 × 22.6	4	92	368
W. P. Fox & Sons, ...	July 12, 1910	47.8 × 22.6	8	95	760
T. F. Boyle & Co., ...	Sept. 15, 1910	48.1 × 23.1	2	87	174
Champion Tanning Company, . . .	Jan. 9, 1911	46.8 × 22.9	4	71	284
Stoneham Tanning Company, . . .	May 1, 1911	43.8 × 19.5	2	79	178
American Glue Company, . . .	Oct. 1, 1910	47.1 × 23.0	2½	130	325
Winchester Manufacturing Company, .	1902	35.5 × 24.7 67.2 × 12.0	7	65	455
Total, ...	-	-	-	-	6,458

No. 2. — *Weir Measurements of Manufacturing Drainage entering the Metropolitan Sewer from Settling Basins at Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.*

NAME.	Weir Measurements (Gallons per 24 Hours).			Maximum Rate of Flow (Gallons per 24 Hours). 1911.	Average Rate of Flow for Nine-hour Day Period (8 A.M. to 5 P.M.) (Gallons per 24 Hours). 1911.	Estimated Per Cent. of Present Business to Maximum Capacity.	Estimated Rate of Flow for Nine-hour Day Period of Maximum Business Capacity (Gallons per 24 Hours).
	1909.	1910.	1911.				
Beggs & Cobb Company, Basin No. 1,	213,000	127,000	47,000	129,000	91,000	83⅓	-
Beggs & Cobb Company, Basin No. 2,		57,000	65,000	289,000	116,000	83⅓	-
Beggs & Cobb Company, Basin No. 3,		-	60,000	394,000	122,000	83⅓	-
American Hide and Leather Company, Factory E.	40,000[1]	40,000	41,000	79,000	61,000	89	-
American Hide and Leather Company, Factory D.	50,000[1]	2,000[1]	2,000[1]	-	2,000[1]	-[2]	-
Cottle Leather Company, . . .	50,000[1]	1,000[1]	1,000[1]	-	1,000[1]	-[2]	-
B. F. Kimball & Co., . . .	75,000[1]	75,000	25,000	70,000	50,000	66⅔	-
E. Cummings Leather Company, .	52,000[1]	52,000	38,000	144,000	79,000	80	-
W. P. Fox & Sons, ...	80,000[1]	66,000	62,000	370,000	122,000	90	-
T. F. Boyle & Co., ...	120,000[1]	116,000	56,000	186,000	108,000	75	-
Champion Tanning Company, . .	50,000[1]	38,000	47,000	225,000	76,000	45	-
Stoneham Tanning Company, . .	150,000[1]	100,000[1]	129,000	413,000[1]	251,000[1]	25	-
American Glue Company, . .	134,000	83,000	91,000	207,000	91,000	90	-
Winchester Manufacturing Company,	158,000	145,000	169,000	562,000	300,000	100	-
Total, ...	1,172,000	902,000	833,000	3,068,000	1,470,000	-	2,700,000

[1] Estimated.

[2] Not tanning.

SOUTH METROPOLITAN SYSTEM.

Sewage Lifting Station at Hough's Neck, Quincy.

During the year, the city of Quincy has connected with the Sewage Lift Works a length of about 800 feet of 18-inch pipe sewer. At the date of this report, four houses are connected with this sewer. The city expects to extend this local sewer during the coming year and take in the drainage of much of the low area in the vicinity of the lifting station.

Regular pumping was started at the lifting station April 4, 1911, and involves operating one of the 6-inch pumps for about half an hour each day. As at present operated, this involves no increase in cost of coal or labor at the Nut Island Screen-house.

SOUTH METROPOLITAN OUTFALLS.

The 60-inch outfall pipes in the harbor have been in operation seven years at the date of this report. These pipes are in normal condition and free from deposit. During the past year the average flow through them has been 42,000,000 gallons of sewage per day, with a maximum rate of 137,500,000 gallons in the month of July, 1911.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan sewerage stations, consisting of rags, paper and other floating materials, has during the year amounted to 3,714 cubic yards. This is equivalent to 5.2 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan sewerage stations has amounted to 2,439 cubic yards, equal to 4.3 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers, siphons and outfall pipes indicate that they are free from deposit.

Respectfully submitted,

WILLIAM M. BROWN,
Chief Engineer of Sewerage Works.

BOSTON, January 1, 1912.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contracts made before

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	312	40-million-gallon pumping engine.	4	$105,700 00	$99,769 00[1]	Holly Mfg. Co., Buffalo, N. Y.
2	314[2]	Building pressure tunnel about 1,900 feet in length, and laying 500 feet of 80-inch steel pipe and 930 feet of 60-inch pipe in Newton, Sect. 7 of the Weston Aqueduct supply mains.	9	105,201 00	102,150 00[1]	Joseph Hanreddy, Chicago, Ill.
3	320[2]	2 vertical fire-tube boilers for Chestnut Hill Low Service Pumping Station.	4	10,640 00	10,448 00[1]	Robb-Mumford Boiler Co., Boston.
4	325[2]	27.8 tons 24-inch cast-iron water pipes; 103.4 tons special castings.	4	8,420 12	5,931 16[1]	Standard Cast Iron Pipe and Foundry Co., Bristol, Pa.
5	328[2]	Hand travelling crane, .	2	3,096 00	2,500 00[1]	Niles-Bement-Pond Co., Boston.
6	329[2]	Fuel economizer, . .	2	1,822 00	1,740 00[1]	B. F. Sturtevant Co., Boston.
7	330[2]	Hydro-electric plant at Wachusett Dam.	7[3]	71,550 00	71,500 00[1]	S. Morgan Smith Co., York, Pa.
8	331[2]	4 48-inch hydraulic lift valves.	2	6,380 00	5,068 00[1]	The Fairbanks Company, Boston.
9	332[2]	363 feet 80-inch riveted steel pipe.	4	4,270 00	3,650 00[1]	Hodge Boiler Works, East Boston.
10	333[2]	65,600 lbs. special castings, .	–[4]	–	–	Florence Iron Works, Philadelphia, Pa.
11	334[2]	35,760 lbs. special castings, .	2	1,891 70	1,430 40[1]	Davis & Farnum Mfg. Co., Waltham, Mass.
12	335[2]	54,000 lbs. special castings, .	4	1,512 00[1]	1,431 00	Builders Iron Foundry, Providence, R. I.
13	336[2]	49,800 lbs. special castings, .	5[5]	1,394 40	1,369 50	United States Cast Iron Pipe and Foundry Co., New York, N. Y.

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[1] Contract based upon this bid.

[2] Contract completed.

[3] Includes separate and combined bids for hydraulic and electric plant.

APPENDIX No. 1.

THE YEAR 1911 — WATER WORKS.

1911 have been given in previous reports.]

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
Sept. 21, 1909	-	Engine in service since March 27, 1911, but not yet tested.	$99,000 00	1
Apr. 28, 1910	Nov. 25, 1911	- -	114,472 13	2
Apr. 29, 1910	Jan. 2, 1911	- -	10,448 00	3
May 18, 1910	Mar. 29, 1911	- -	5,988 45	4
Oct. 24, 1910	Feb. 10, 1911	- -	2,500 00	5
Oct. 11, 1910	May 11, 1911	- -	1,740 00	6
Dec. 3, 1910	Aug. 10, 1911	- -	68,389 62	7
Jan. 3, 1911	June 19, 1911	For each valve, $1,267, ...	5,108 00	8
Dec. 6, 1910	July 31, 1911	- -	3,725 57	9
Jan. 10, 1911	Apr. 3, 1911	For special castings, $2.55 and $4.12 per 100 pounds,	2,561 68	10
Jan. 10, 1911	Apr. 3, 1911	For special castings, $0.04 per pound, . . .	1,610 56	11
Jan. 10, 1011	Apr. 3, 1911	For special castings, $0.028 per pound, . . .	1,562 85	12
Jan. 10, 1911	Apr. 3, 1911	For special castings, $57 per ton of 2,000 pounds, .	1,340 64	13

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[4] On a portion of these castings competitive bids were not received.

[5] As lowest bidder had been awarded Contract No. 333, and next to the lowest bidder Contract No. 335 contract was awarded to third bidder in order to expedite the work.

CONTRACTS MADE AND PENDING DURING THE

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	337[2]	4 Venturi meters for Wachusett Dam.	–[6]	–	–	Builders Iron Foundry, Providence, R. I.
2	338[2]	Hydraulic turbine for Wachusett Dam.	2	$1,100 00	$1,065 00[1]	S. Morgan Smith Co., York, Pa.
3	339[2]	2,680 tons cast-iron water pipe, 60 tons special castings.	4	62,209 00	60,828 00[1]	United States Cast Iron Pipe and Foundry Co., New York, N. Y.
4	340	30 water valves; 4 24-inch, 8 20-inch, 12 16-inch, 6 12-inch valves.	3	6,434 00	5,000 00[1]	Pratt & Cady Co., Hartford, Conn.
5	341[2]	Laying 10,200 feet of 24-inch cast-iron water pipe in Boston.	5	12,343 00	11,641 50[1]	Michele Russo & Son, Boston.
6	342[2]	Cables in transmission line, Clinton Power Plant.	2	83.25 cts. per lin. ft.	77.7 cts.[1] per lin. ft.	Standard Underground Cable Co., Boston.
7	343[2]	Laying 6,700 feet of 20-inch cast-iron water pipe in Hyde Park, Mass.	7	8,446 00	8,169 00[1]	James L. Bryne, Dorchester, Mass.
8	344[2]	Laying 2,840 feet of 20-inch cast-iron water pipe with ordinary joints and 139 feet with flexible joints in Boston and Hyde Park.	3	5,469 00	4,507 60[1]	Andrew M. Cusack, Boston.
9	345[2]	2 20-inch Venturi meter tubes and 2 Type M register indicator recorders.	–[6]	–	–	Builders Iron Foundry, Providence, R. I.
10	346	2 3-million-gallon pumping engines.	Engine No. 1, 5.	7,886 00	7,525 00[1]	Laidlaw-Dunn-Gordon Co., Cincinnati, O.
			Engine No. 2, 7.	8,825 00[1]	8,738 00	
11	19-M[2]	Improvement of Lake Cochituate, surface water drains in Framingham, Natick and Wayland.	7	31,298 00	30,981 00[1]	The Henry Spinach Contracting Co., Waterbury, Conn.

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[1] Contract based upon this bid.

[2] Contract completed.

YEAR 1911 — WATER WORKS — *Continued.*

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
Jan. 26, 1911	Nov. 9, 1911	For 4 very special Venturi meters, $5,000, . .	$5,000 00	1
Mar. 6, 1911	Nov. 15, 1911	Before the contract was executed it was decided that a fly-wheel was necessary in connection with the turbine. This necessitated the use of a larger shaft. The contract price, $1,250, therefore, includes an allowance of $185 for fly-wheel and larger shaft.	1,250 00	2
May 24, 1911	Oct. 28, 1911	Straight pipe, $21.60 per ton of 2,000 pounds; special castings, $49 per ton of 2,000 pounds.	57,267 67	3
June 3, 1911	-	For whole work, $5,000, ...	4,740 00	4
June 24, 1911	Dec. 12, 1911	For laying 24-inch cast-iron pipe, $1.03 per lin. ft.; for rock excavation above and below regular grade, $6 per cu. yd.; for chamber for 24-inch valve, $45; for chambers for blow-offs and air valves, $35 per chamber; for concrete masonry, $5 per cu. yd.	15,980 35	5
June 8, 1911	June 22, 1911	For furnishing and installing 2 cables, each about 889 feet long, containing 3 No. 0, B. &. S. G. conductors, each conductor composed of 7 strands, insulated with 7/32-inch × 7/32-inch paper, laterals filled and enclosed in a pure lead sheath ⅛-inch thick, for 13,800 volts working pressure and 30,000 volts ½ hour factory test pressure, the sum of $0.777 per lin. ft.	1,378 10	6
July 12, 1911	Nov. 11, 1911	For laying 20-inch cast-iron pipe, $0.87 per lin. ft.; for laying 6-inch, 12-inch and 16-inch cast-iron pipe for blow-offs and connections, $1 per lin. ft.; for rock excavation above and below regular grade, $5 per cu. yd.; for earth excavation below regular grade, $1 per cu. yd.; for chambers for 20-inch valves, $50 per chamber; for chambers for 16-inch and smaller valves, $40 per chamber; for concrete masonry, $8 per cu. yd.	12,292 15	7
Aug. 28, 1911	Nov. 21, 1911	For laying 20-inch cast-iron pipe with ordinary joints, $1.24 per lin. ft., with flexible joints, under N. Y., N. H. & H. R.R., $4.95 per lin. ft.; for rock excavation above and below regular grade, $5 per cu. yd.; for earth excavation below regular grade, $1.50 per cu. yd.; for chambers for valves, $45 per chamber; for concrete masonry, $7 per cu. yd.	4,778 68	8
July 24, 1911	Aug. 23, 1911	For 20-inch Venturi meter tubes, $340 each; for Type M register indicator recorders, $400 each.	1,474 40	9
Sept. 18, 1911	-	For Engine No. 1, horizontal cross-compound, crank and fly-wheel, capacity, 3,000,000 gallons against a head of 50 feet, $7,525; for Engine No. 2, horizontal cross-compound, crank and fly-wheel, capacity, 3,000,000 gallons against a head of 140 feet, $8,825.	-	10
June 22, 1910	May 8, 1911	- -	31,067 52	11

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[1] Competitive bids were not received.

CONTRACTS MADE AND PENDING DURING THE

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	20-M[2]	950 tons New River or Pocahontas coal: 250 tons for Arlington Pumping Station; 700 tons for Spot Pond Pumping Station.	3	$4.55 and $4.90 per ton.	$4.20[1] and $4.85 per ton.	New England Coal & Coke Co., Boston.
2	21-M[2]	4,000 tons Beaver Run coal for Chestnut Hill Pumping stations.	7	$3.84 per ton.	$3.83[1] per ton.	Gorman-Leonard Coal Co., Worcester, Mass.
3	23-M	1,050 tons New River or Pocahontas coal: 350 tons for Arlington Pumping Station, 700 tons for Spot Pond Pumping Station.	4[7] 3[8]	$3.88 and $4.68, July to Apr., $4.78 Apr. to July per ton.	$3.80[1] and $4.35 per ton.	New England Coal and Coke Co., Boston.
4	24-M	5,500 tons Beaver Run coal for Chestnut Hill Pumping stations.	10	$3.79 [1] per ton.	$3.75 per ton.	Gorman-Leonard Coal Co., Worcester, Mass.
5	Special [2] Order.	Erecting boilers at Chestnut Hill Pumping Station.	2	660 00	600 00[1]	F. Knight & Son, Boston.
6	Special [2] Order.	2 smoke flues at Chestnut Hill Pumping Station.	4	555 00	536 00[1]	B. F. Sturtevant Co., Boston.
7	Special[2] Order.	Special castings, . . .	5	1,092 12	958 00[1]	Warren Foundry & Machine Co., New York, N. Y.
8	Special [2] Order.	Furnishing and applying non-conducting covering to boilers, smoke flue and steam piping, Chestnut Hill Pumping Station.	4	755 00	739 00[1]	Philip Carey Co., Boston.
9	Special [2] Order.	Governor for exciter wheel of Power Plant at Wachusett Dam.	–[6]	–	–	Lombard Governor Co., Ashland, Mass.
10	Special [2] Order.	Furnishing and placing sheraduct iron conduit in floor of Power House at Wachusett Dam.	2	730 58	651 23[1]	M. B. Foster Electric Co., Boston.
11	Special [2] Order.	400-gallon power sprayer, .	–[6]	–	–	Fitzhenry-Guptill Co., Boston.

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[1] Contract based upon this bid.

[2] Contract completed.

Year 1911 — Water Works — *Continued.*

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
July 25, 1910	Apr. 25, 1911	- -	$3,428 48	1
Aug. 18, 1910	May 16, 1911	- -	16,689 81	2
July 8, 1911	-	$3.80 per ton of 2,240 pounds delivered on cars at the Arlington Pumping Station; $4.35 per ton of 2,240 pounds delivered in bins at the Spot Pond Pumping Station.	3,090 25	3
Oct. 24, 1911	-	$3.79 per ton of 2,240 pounds delivered on cars at Chestnut Hill Pumping stations, until Nov. 15, 1912, and $3.83 per ton of 2,240 pounds after that date.	4,809 59	4
Dec. -, 1910	Feb. 2, 1911	- -	600 00	5
Dec. 23, 1910	Feb. 17, 1911	- -	499 88	6
Feb. 27, 1911	Apr. 12, 1911	For special castings 2½ cents per pound, . .	1,034 60	7
Mar. 6, 1911	Mar. 31, 1911	For whole work, $739, ...	739 00	8
Mar. 15, 1911	May 15, 1911	For whole work, $753.50, ...	753 50	9
Mar. 18, 1911	May 25, 1911	Sheraduct iron conduit and fittings, $594.49; labor, $330.61; express, $0.40.	925 50	10
May 12, 1911	May 23, 1911	For platform wagon, $300, pump, $410; valve, $12; engine, $355.50; long nozzle, $10; assembling and freight, $19.	1,106 50	11
			$487,353 48	

[6] Competitive bids were not received.

[7] Arlington Station.

[8] Spot Pond Station.

Contracts made and pending during the Year 1911 — Water Works — *Concluded.*

Summary of Contracts.[1]

	Value of Work done Dec. 31, 1911.
Wachusett Department, 10 contracts,	$90,701 45
Distribution Department, 13 contracts,	331,907 40
319 contracts completed from 1896 to 1910, inclusive,	16,391,984 45
	$16,814,593 30
Deduct for work done on 11 Sudbury Reservoir contracts by the City of Boston,	512,000 00
Total of 352 contracts,	$16,302,593 30

[1] In this summary contracts charged to maintenance are excluded.

APPENDIX No. 2.

TABLE No. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1911.*

PLACE.		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.	Princeton,	2.78	2.06	3.54	1.76	1.76	2.08	2.14	5.53	3.04	5.49	3.87	2.89	36.94
	Jefferson,	3.19	2.63	4.11	2.42	1.91	2.24	2.70	5.83	3.08	5.79	4.11	3.06	41.07
	Sterling,	2.72	2.29	3.60	2.12	1.26	2.40	2.12	5.27	3.00	5.22	4.41	3.01	37.42
	Boylston,	2.93	2.75	3.92	2.56	1.44	2.77	3.14	5.21	3.03	4.46	4.17	3.09	39.47
Sudbury Watershed.	Sudbury Dam,	2.78	2.78	3.50	2.49	0.72	2.47	3.35	4.26	2.46	3.70	4.59	3.32	36.42
	Framingham,	2.75	2.64	3.33	2.80	0.72	2.42	3.21	4.66	2.73	3.57	4.39	3.63	36.85
	Ashland Dam,	2.80	2.74	3.57	2.96	1.05	2.37	2.98	5.15	2.67	3.45	4.61	3.67	38.02
	Cordaville,	3.19	2.92	3.96	3.01	1.55	2.84	3.21	5.68	3.12	4.05	4.89	3.80	42.22
Lake Cochituate,		2.74	3.20	3.31	2.73	0.65	2.53	3.42	4.82	2.96	3.53	4.28	3.74	37.91
Chestnut Hill Reservoir,		3.05	3.43	3.27	2.55	0.58	3.84	4.69	5.01	3.59	3.22	4.40	3.65	41.28
Spot Pond,		2.78	3.18	3.47	2.45	1.01	3.69	6.30	4.52	3.34	2.93	4.02	3.72	41.41
Average of all,		2.88	2.78	3.60	2.53	1.15	2.70	3.39	5.08	3.00	4.13	4.34	3.42	39.00
Average, Wachusett watershed,		2.91	2.43	3.79	2.22	1.59	2.37	2.53	5.46	3.04	5.24	4.14	3.01	38.73
Average, Sudbury watershed,		2.88	2.77	3.59	2.81	1.01	2.53	3.19	4.94	2.75	3.69	4.62	3.60	38.38

TABLE NO. 2. — *Rainfall in Inches at Jefferson, Mass., in 1911.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	[2]	–	–	–	0.09	–	–	–	–	[2]	0.14	–
2,	[2]	0.41[3]	–	–	–	–	–	–	–	0.64	–	–
3,	1.26	–	–	–	–	–	–	–	–	–	–	–
4,	–	1.14[3]	–	[2]	–	–	–	–	–	0.44	–	–
5,	–	–	–	[2]	–	[2]	–	–	–	–	–	–
6,	0.05[1]	–	0.23[1]	1.42[3]	–	[2]	0.56	–	0.29	[2]	[2]	–
7,	–	0.61[1]	–	–	–	1.56	–	–	–	0.54[3]	0.63	–
8,	0.20	0.07[1]	–	–	–	–	–	–	[2]	–	–	–
9,	–	–	–	0.52[1]	–	–	–	–	0.71	0.38	–	–
10,	–	–	0.27[1]	–	–	–	–	–	–	–	0.09	–
11,	0.05	–	–	–	–	–	–	–	0.09	–	–	–
12,	[2]	–	–	–	–	[2]	–	–	–	–	0.40	–
13,	[2]	0.12	–	–	–	0.68	–	–	–	–	–	–
14,	0.19	–	–	0.27	–	–	–	–	–	–	[2]	–
15,	0.07[3]	–	1.05[1]	–	–	–	–	1.88	0.50	0.20	0.90[3]	[2]
16,	–	–	–	–	–	–	–	–	–	–	–	[2]
17,	–	0.04	–	–	–	–	0.17	0.06	–	[2]	–	0.98[3]
18,	–	–	0.24[3]	–	–	–	–	0.44	–	[2]	0.94	–
19,	–	–	0.68[1]	–	0.83	–	–	–	–	[2]	–	–
20,	–	0.24[1]	0.08	0.21[1]	–	–	0.10	–	–	[2]	0.08[1]	–
21,	0.05	–	–	–	–	–	–	–	[2]	[2]	–	–
22,	–	–	–	–	–	–	0.08	–	0.44	[2]	–	[2]
23,	–	–	–	–	0.17	–	–	–	–	3.54	–	1.23
24,	–	–	–	–	–	–	0.85	–	–	–	0.75	–
25,	–	–	–	–	0.46	–	–	[2]	0.26	–	–	–
26,	[2]	–	–	–	–	–	–	0.48	–	–	–	–
27,	1.06[3]	–	[2]	–	–	–	–	[2]	0.19	0.05	–	0.30
28,	–	–	0.80	–	–	–	0.94	[2]	–	–	0.18	–
29,	0.26[3]	–	[2]	–	–	–	–	1.84	0.60	–	–	–
30,	–	–	0.76	–	–	–	–	–	–	–	–	[2]
31,	–	–	–	–	0.36	–	–	1.13	–	–	–	0.55[3]
Totals,	3.19	2.63	4.11	2.42	1.91	2.24	2.70	5.83	3.08	5.79	4.11	3.06

Total for the year 41.07 inches.

[1] Snow.
[2] Rainfall included in that of following day.
[3] Rain and snow.

TABLE No. 3. — *Rainfall in Inches at Framingham, Mass., in 1911.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	[2]	[2]	–	–	–	–	–	0.01	–	[2]	0.05	–
2,	[2]	0.35[3]	–	–	–	–	–	–	–	0.61	–	–
3,	[2]	[2]	0.02[1]	–	–	–	–	–	–	[2]	–	–
4,	1.17[3]	1.14[3]	–	[2]	–	–	–	–	–	0.35	–	–
5,	–	–	–	1.48[3]	–	[2]	–	–	–	–	–	–
6,	–	[2]	0.14[1]	–	–	[2]	0.23	–	0.35	[2]	[2]	–
7,	–	0.63[1]	–	–	–	1.60	–	–	–	0.53	0.35	–
8,	0.20	0.07[1]	–	–	0.04	–	–	–	–	–	–	–
9,	–	–	–	0.67[1]	0.02	–	–	–	0.58	–	–	0.04
10,	–	–	0.16[3]	–	–	0.05	–	–	–	–	0.13	–
11,	0.10	–	–	–	–	[2]	–	–	0.17	–	–	–
12,	–	–	0.06	–	–	[2]	–	–	–	–	0.51	–
13,	0.11	[2]	–	–	–	[2]	–	–	–	–	–	–
14,	0.07	0.09[1]	–	0.12	–	0.61	–	–	–	–	[2]	[2]
15,	0.02[1]	–	0.98[3]	–	–	–	–	0.41	[2]	[2]	0.91[3]	[2]
16,	–	–	–	0.03[1]	–	0.08	–	0.04	0.44	0.04	–	[2]
17,	–	[2]	–	–	–	–	0.09	–	–	0.05	–	1.01[3]
18,	–	0.08	0.25	–	–	–	–	0.62	–	[2]	0.97	0.01[1]
19,	–	–	0.58[3]	[2]	0.32	–	–	–	–	0.84	–	–
20,	–	0.27[1]	–	0.37	–	0.04	0.04	–	–	–	[2]	–
21,	–	–	–	–	–	–	–	–	[2]	[2]	0.03[3]	–
22,	0.01[1]	0.01[1]	0.03	[2]	–	0.02	–	–	0.14	[2]	–	[2]
23,	–	–	–	0.03[3]	0.02	–	–	–	–	0.94	–	1.73
24,	–	–	–	–	0.02	–	0.85	[2]	–	–	[2]	–
25,	–	–	–	–	0.15	–	–	[2]	0.30	–	1.06	–
26,	0.14	–	[2]	–	–	0.02	–	[2]	0.17	–	–	[2]
27,	[2]	–	[2]	–	–	–	–	[2]	0.04	0.04	–	0.27
28,	0.81	–	0.48	–	–	–	2.00	1.04	–	–	0.38	–
29,	[2]	–	[2]	–	–	–	–	[2]	0.54	–	–	–
30,	0.12[3]	–	0.63	0.10	–	–	–	[2]	–	–	–	[2]
31,	–	–	–	–	0.15	–	–	2.54	–	0.17	–	0.57[3]
Totals,	2.75	2.64	3.33	2.80	0.72	2.42	3.21	4.66	2.73	3.57	4.39	3.63

Total for the year 36.85 inches.

[1] Snow. [2] Rainfall included in that of following day. [3] Rain and snow.

TABLE NO. 4.—*Rainfall in Inches at Chestnut Hill Reservoir in 1911.*

DATE.	Amount.	Duration.
Jan. 1,	.51	6.00 P.M. to 8.00 A.M.
Jan. 2,		
Jan. 3,	.98[2]	5.00 A.M. to 6.45 A.M.
Jan. 4,		
Jan. 8,	.28	9.30 P.M. to 2.05 A.M.
Jan. 9,		
Jan. 11,	.14	9.45 P.M. to 1.25 A.M.
Jan. 12,		
Jan. 13,	.15	1.00 P.M. to 7.30 P.M.
Jan. 14,		
Jan. 26,	.16[2]	5.00 P.M. to 7.00 P.M.
Jan. 27,	.74	10.30 A.M. to 6.10 A.M.
Jan. 28,		
Jan. 29,	.09[2]	5.00 P.M. to 11.00 P.M.
Total,	3.05	
Feb. 2,	.52[1]	4.50 A.M. to 2.50 A.M.
Feb. 3,		
Feb. 3,	1.11[2]	7.45 A.M. to 1.30 P.M.
Feb. 4,		
Feb. 6,	.94[1]	4.00 P.M. to 4.00 P.M.
Feb. 7,		
Feb. 8,	.11[1]	2.30 P.M. to 9.40 P.M.
Feb. 13,	.25[1]	2.30 P.M. to 1.10 P.M.
Feb. 14,		
Feb. 17,	.18[2]	11.45 A.M. to 6.00 P.M.
Feb. 20,	.32[1]	8.15 A.M. to 11.55 P.M.
Total,	3.43	
Mar. 3,	.03[1]	6.30 P.M. to 8.30 P.M.
Mar. 6,	.18[1]	5.05 A.M. to 9.30 P.M.
Mar. 10,	.21	8.20 A.M. to 4.00 P.M.
Mar. 12,	.08	1.10 P.M. to 8.10 P.M.
Mar. 15,	.86	2.05 A.M. to 10.00 A.M.
Mar. 16,	.14[1]	12.05 A.M. to 5.05 A.M.
Mar. 18,	.15	6.10 A.M. to 12.30 P.M.
Mar. 19,	.52[2]	6.30 P.M. to 12.05 A.M.
Mar. 20,		
Mar. 27,	.49	3.15 A.M. to 3.15 A.M.
Mar. 28,		
Mar. 29,	.61	7.00 P.M. to 2.50 A.M.
Mar. 30,		
Total,	3.27	
Apr. 4,	1.40	5.30 P.M. to 10.45 P.M.
Apr. 5,		
Apr. 9,	.60[1]	1.55 A.M. to 1.15 P.M.
Apr. 14,	.12	5.00 P.M. to 11.30 P.M.
Apr. 19,	.35	3.30 P.M. to 12.25 P.M.
Apr. 20,		
Apr. 30,	.08	9.00 A.M. to 7.00 A.M.
May 1,		
Total,	2.55	
May 8,	.09	10.50 P.M. to 12.25 A.M.
May 9,		
May 9,	.04	7.00 P.M. to 12.35 A.M.
May 10,		
May 19,	.04	5.35 A.M. to 7.30 A.M.
May 24,	.12	1.35 A.M. to 2.05 A.M.
May 25,	.18	7.30 A.M. to 3.30 P.M.
May 31,	.11	9.30 A.M. to 5.35 A.M.
June 1,		
Total,	.58	
June 5,	2.58	4.45 P.M. to 8.00 A.M.
June 7,		
June 10,	.11	4.35 P.M. to 10.25 P.M.
June 11,	.96	6.00 P.M. to 5.00 P.M.
June 13,		
June 16,	.13	12.15 P.M. to 4.30 P.M.
June 20,	.06	8.15 A.M. to 7.00 P.M.
Total,	3.84	
July 6,	.18	7.30 P.M. to 11.00 P.M.
July 24,	.86	9.10 A.M. to 1.10 A.M.
July 25,		
July 28,	3.65	2.50 A.M. to 8.30 P.M.
Total,	4.69	
Aug. 15,	.51	5.00 P.M. to 11.50 P.M.
Aug. 17,	.05	4.00 A.M. to 4.40 A.M.
Aug. 18,	.48	2.45 P.M. to 8.00 P.M.
Aug. 24,	.25	11.00 P.M. to 8.00 A.M.
Aug. 26,		
Aug. 27,	.89	4.50 A.M. to 6.15 A.M.
Aug. 28,		
Aug. 28,	.23	12.40 P.M. to 1.05 P.M.
Aug. 29,	1.32	2.00 A.M. to 11.20 A.M.
Aug. 30,		
Aug. 31,	1.28	12.05 A.M. to 9.30 P.M.
Total,	5.01	
Sept. 6,	.20	7.05 A.M. to 11.05 A.M.
Sept. 9,	.47	8.35 A.M. to 4.30 P.M.
Sept. 11,	.14	10.00 A.M. to 2.00 P.M.
Sept. 15,	.54	2.30 P.M. to 5.45 A.M.
Sept. 16,		
Sept. 22,	.16	2.45 A.M. to 7.30 A.M.
Sept. 25,	1.58	5.40 P.M. to 10.15 A.M.
Sept. 26,		
Sept. 27,	.06	6.30 P.M. to 8.45 P.M.
Sept. 29,	.44	7.45 A.M. to 8.15 P.M.
Total,	3.59	

[1] Snow.

[2] Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1911* — Concluded.

DATE.	Amount.	Duration.
Oct. 1, .	.67	5.30 P.M. to
Oct. 2, .		10.30 A.M.
Oct. 4, .	.04	6.35 A.M. to 7.00 A.M.
Oct. 4, .	.42	9.45 A.M. to 10.00 P.M.
Oct. 6, .	.55	7.50 P.M. to
Oct. 7, .		10.30 A.M.
Oct. 15, .	.15	12.50 P.M. to 6.15 P.M.
Oct. 17, .	.06	10.45 A.M. to 8.45 P.M.
Oct. 18, .	.37	8.45 A.M. to
Oct. 19, .		12.25 A.M.
Oct. 19, .	.03	1.30 P.M. to 4.00 P.M.
Oct. 21, .	.68	9.30 A.M. to
Oct. 23, .		8.00 A.M.
Oct. 27, .	.04	3.30 P.M. to 8.20 P.M.
Oct. 31, .	.21	10.30 A.M. to
Nov. 1, .		8.00 A.M.
Total, .	3.22	
Nov. 1, .	.05	8.00 A.M. to 11.30 P.M.
Nov. 6, .	.35	6.00 P.M. to
Nov. 7, .		5.00 A.M.
Nov. 10, .	.13	4.00 A.M. to 6.00 P.M.
Nov. 12, .	.50	8.10 P.M. to 11.50 P.M.
Nov. 14, .	.85[2]	9.45 P.M. to
Nov. 15, .		8.00 A.M.
Nov. 18, .	1.01[2]	12.20 A.M. to 1.00 P.M.
Nov. 20, .	.03	3.25 P.M. to 5.40 P.M.
Nov. 24, .	.83	6.35 A.M. to
Nov. 25, .		3.15 A.M.
Nov. 28, .	.65	2.00 P.M. to
Nov. 29, .		12.45 A.M.
Total, .	4.40	
Dec. 9, .	.06	11.30 A.M. to 4.00 P.M.
Dec. 15, .	1.03[2]	2.30 A.M. to
Dec. 17, .		8.00 A.M.
Dec. 22, .	1.80	4.20 P.M. to
Dec. 23, .		6.45 A.M.
Dec. 26, .	.21	10.45 P.M. to
Dec. 27, .		10.50 A.M.
Dec. 31, .	.35[1]	4.00 A.M. to 12.45 P.M.
Dec. 31, .	.20	1.15 P.M. to 11.00 P.M.
Total, .	3.65	

Total for year 41.28 inches.

[1] Snow.

[2] Rain and snow.

TABLE No. 5. — *Rainfall in Inches on the Wachusett Watershed,*[1] *1897 to 1911.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897,	3.46	2.86	4.01	2.32	5.06	5.11	8.65	3.47	1.93	0.94	7.62	6.41	51.84
1898,	6.65	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899,	2.93	5.12	6.75	1.94	1.33	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900,	4.56	8.69	6.19	2.76	4.34	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901,	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902,	2.72	4.91	5.27	4.36	2.24	2.51	3.87	3.95	4.26	6.36	0.93	7.20	48.58
1903,	2.85	4.42	6.58	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904,	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905,	6.10	1.72	3.95	2.60	0.83	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906,	2.59	2.74	5.17	3.12	6.58	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
1907,	2.84	2.32	1.82	2.65	2.96	3.54	3.03	1.26	9.50	5.68	5.74	4.40	45.74
1908,	3.40	4.82	2.77	2.62	5.34	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
1909,	3.52	6.10	4.38	5.71	2.65	3.03	4.25	3.59	3.90	1.70	1.68	3.99	44.50
1910,	5.86	5.24	1.09	3.01	2.13	4.36	1.52	3.87	2.86	1.40	4.17	2.34	37.85
1911,	2.91	2.43	3.79	2.22	1.59	2.37	2.53	5.46	3.04	5.24	4.14	3.01	38.73
Totals,	56.16	58.46	63.26	57.93	49.68	60.57	61.57	64.65	58.09	51.95	51.70	63.83	697.85
Average (15 years),	3.74	3.90	4.22	3.86	3.31	4.04	4.11	4.31	3.87	3.46	3.45	4.26	46.53

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[1] Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December 1911, Princeton, Jefferson, Sterling and Boylston.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1911.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74

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[1] See note at bottom of page 174.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1911* — Concluded.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
1899,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78	37.21
1900,	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65
1901,	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902,	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903,	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92	42.82
1905,	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906,	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
1907,	3.28	2.17	1.91	3.41	3.63	3.53	1.86	1.07	8.76	4.17	6.12	4.47	44.38
1908,	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15
1909,	3.98	5.79	4.26	4.67	2.43	2.81	1.59	2.93	4.74	1.12	3.38	4.05	41.75
1910,	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64
1911,	2.88	2.77	3.59	2.81	1.01	2.53	3.19	4.94	2.75	3.69	4.62	3.60	38.38
Totals,	153.05	155.61	161.69	129.37	121.16	115.90	131.38	143.51	129.47	145.09	142.69	140.71	1,669.63
Average (37 years),	4.14	4.21	4.37	3.50	3.27	3.13	3.55	3.88	3.50	3.92	3.86	3.80	45.13

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[1] Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June, 1898, to December, 1911, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE NO. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile*[1] *from 1897 to 1911.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	Mean for 15 Years, 1897-1911.
January, . .	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000	659,000	1,266,000	1,132,000	1,458,000	1,738,000	592,000	1,846,000	773,000	1,212,000
February, . .	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000	692,000	1,736,000	2,556,000	1,845,000	625,000	1,430,000
March, . .	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000	2,192,000	2,129,000	2,640,000	1,339,000	2,690,000
April, . .	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000	1,269,000	2,422,000	1,034,000	1,393,000	2,151,000
May, . . .	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000	965,000	1,415,000	1,212,000	608,000	461,000	1,151,000
June, . . .	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	542,000	1,184,000	773,000	403,000	632,000	824,000	351,000	810,000
July, . . .	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	365,000	728,000	335,000	220,000	233,000	62,000	57,000	416,000
August, . .	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	321,000	591,000	87,000	443,000	193,000	186,000	188,000	420,000
September, .	380,000	676,000	250,000	127,000	320,000	241,000	375,000	494,000	1,228,000	277,000	810,000	88,000	208,000	145,000	181,000	387,000
October, . .	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000	347,000	367,000	530,000	1,382,000	158,000	90,000	68,000	718,000	548,000
November, .	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	442,000	749,000	2,540,000	125,000	363,000	354,000	1,035,000	833,000
December, .	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,018,000	794,000	1,961,000	387,000	537,000	391,000	1,067,000	1,260,000
Average, .	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	926,000	1,043,000	1,180,000	847,000	918,000	828,000	682,000	1,107,000
Average driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000	413,000	541,000	613,000	725,090	238,000	270,000	201,000	327,000	567,000

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[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, 2.4 per cent. in 1903, 3.6 per cent. in 1904, 4.1 per cent. in 1905, 5.1 per cent. in 1906, 6.0 per cent. in 1907, 7.0 per cent. in 1908, 1909 and 1910, and 6.5 per cent. in 1911.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1911.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
January,	103,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,00	335,000	995,000	1,235,000	1,461,000	2,589,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000	4,801,000	2,829,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000	2,868,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000	1,947,000	2,620,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,336,000	720,000	1,009,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000	203,000	413,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000	116,000	115,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240 000	94,000	214,000
September,	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000	117,000	111,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000	146,000	190,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000	673,000	369,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000	1,020,000	643,000
Average,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000	1,087 000	1,154,000
Average, driest six months,	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000	223,000	234,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1911* — Continued.

MONTH.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
January,	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	693,000	1,034,000	1,084,000	845,000	1,638,000	2,288,000	794,000
February,	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000	1,067,000	3,022,000	1,381,000	3,800,000
March,	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000	2,604,000	4,205,000	3,654,000
April,	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000	2,521,000	1,350,000
May,	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	360,000	915,000	1,246,000	511,000	1,312,000
June,	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000	962,000	530,000	66,000	316,000
July,	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000	658,000	231,000	19,000	—18,000
August,	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	220,000	57,000	591,000	1,107,000	—35,000	—34,000
September,	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000	182,000	369,000	94,000	65,000
October,	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000	94,000	1,160,000	115,000	186,000
November,	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000	909,000	1,986,000	304,000	663,000
December,	3,043,000	2,241,000	996,000	544,000	485,000	796,000	716,000	1,782,000	657,000	1,584,000	1,799,000	220,000	1,096,000
Average	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000	973,000	1,082,000
Average, driest six months,	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000	564,000	777,000	93,000	194,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1911* — Concluded.

MONTH.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	Mean for 37 Years, 1875-1911.
January,	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000	1,925,000	392,000	1,490,000	519,000	1,209,000
February,	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	624,000	1,536,000	2,286,000	1,849,000	700,000	1,735,000
March,	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000	2,257,000	1,734,000	1,954,000	1,144,000	2,791,000
April,	4,204,000	1,885,000	2,261,000	3,294,000	1,643,000	1,949,000	1,607,000	1,117,000	1,721,000	667,000	1,426,000	1,989,000
May,	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	888,000	1,046,000	1,004,000	277,000	318,000	1,058,000
June,	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000	194,000	239,000	516,000	213,000	507,000
July,	306,000	66,000	445,000	62,000	177,000	398,000	9,000	—14,000	—121,000	—102,000	—14,000	166,000
August,	424,000	135,000	307,000	170,000	114,000	180,000	—104,000	102,000	—45,000	—73,000	20,000	241,000
September,	305,000	178,000	130,000	397,000	1,246,000	19,000	541,000	—82,000	149,000	5,000	76,000	246,000
October,	412,000	506,000	492,000	191,000	158,000	301,000	741,000	47,000	—51,000	—51,000	296,000	449,000
November,	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000	71,000	82,000	176,000	593,000	804,000
December,	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,032,000	136,000	263,000	221,000	908,000	1,016,000
Average	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,010,000	694,000	625,000	570,000	514,000	1,013,000
Average, driest six months,	445,000	271,000	388,000	228,000	403,000	341,000	471,000	44,000	40,000	29,000	151,000	400,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, particularly during months of small yield, due to unavoidable inaccuracies in the measurement of large quantities of water received from the Wachusett Reservoir.

TABLE No. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1911.*

[Watershed above dam = 118.19 square miles.]

MONTH.	GALLONS PER DAY.							Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
	Discharged into Wachusett Aqueduct.[1]	Diverted to the City of Worcester.	Wasted into River below Dam.	Seepage through the North Dike.	STORAGE.[2]		Total yield of Watershed.			
					Gain.	Loss.				
January,	105,097,000	-	1,645,000	748,000	-	16,116,000	91,374,000	2.91	1.379	47.5
February,	52,654,000	-	1,696,000	750,000	18,743,000	-	73,843,000	2.43	1.007	41.4
March,	38,784,000	-	1,568,000	752,000	117,206,000	-	158,310,000	3.79	2.389	63.0
April,	250,000[3]	-	1,877,000	827,000	161,653,000	-	164,607,000	2.22	2.404	108.5
May,	27,797,000	-	1,816,000	871,000	23,958,000	-	54,442,000	1.59	0.822	51.6
June,	61,537,000	-	2,113,000	877,000	-	23,050,000	41,477,000	2.37	0.606	25.5
July,	78,739,000	-	2,761,000	858,000	-	75,681,000	6,677,000	2.53	0.101	4.0
August,	85,658,000	4,284,000	2,526,000	822,000	-	71,061,000	22,229,000	5.46	0.335	6.1
September,	71,047,000	2,753,000	1,820,000	800,000	-	54,980,000	21,440,000	3.04	0.313	10.3
October,	70,161,000	6,710,000	1,358,000	778,000	5,816,000	-	84,823,000	5.24	1.280	24.4
November,	115,540,000	10,877,000	1,797,000	776,000	-	6,713,000	122,277,000	4.14	1.786	43.1
December,	79,952,000	2,342,000	1,758,000	774,000	41,239,000	-	126,065,000	3.01	1.903	63.2
Total,	-	-	-	-	-	-	-	38.73	14.325	-
Average for year,	65,746,000	2,253,000	1,396,000	803,000	9,913,000	-	80,611,000	-	-	37.0

[1] Including 145,300 gallons per day drawn from aqueduct for the supply of the Westborough Insane Hospital.

[2] Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

[3] Quantity wasted in cleaning aqueduct.

TABLE NO. 10.—*Sudbury System.* —*Statistics of Flow of Water, Storage and Rainfall in 1911.*

[Watershed from 1875 to 1878 inclusive = 77.764 square miles; in 1879 and 1880 = 78.238 square miles; and from 1881 to 1911 inclusive = 75.2 square miles.]

MONTH.	GALLONS PER DAY.											
	Water received from Wachusett Reservoirs.[1]	Water discharged through Sudbury Aqueduct.	Water discharged through Weston Aqueduct.	Water used by Framingham Water Works.	Water diverted from Watershed by Sewers, etc.	Water wasted into River below Lowest Dam.	STORAGE.		Total Yield of Watershed.	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
							Gain.	Loss.				
January, . .	104,952,000	89,235,000	28,571,000	768,000	697,000	21,958,000	2,726,000	-	39,003,000	2.88	0.925	32.1
February, .	52,500,000	79,300,000	28,182,000	675,000	1,000,000	9,179,000	-	13,164,000	52,671,000	2.77	1.128	40.7
March, . .	38,619,000	69,365,000	28,242,000	681,000	913,000	18,284,000	7,197,000	-	86,061,000	3.59	2.042	56.9
April, . .	-	66,560,000	27,943,000	707,000	1,110,000	18,253,000	-	7,430,000	107,210,000	2.81	2.462	87.4
May, . .	27,726,000	84,087,000	28,235,000	794,000	629,000	1,503,000	-	63,623,000	23,900,000	1.01	0.567	56.1
June, . .	61,360,000	78,430,000	27,903,000	737,000	593,000	1,500,000	-	31,800,000	16,003,000	2.53	0.367	14.5
July, . .	78,535,000	66,603,000	29,323,000	842,000	445,000	1,500,000	-	21,252,000	—1,074,000	3.19	—0.025	—0.8
August, . .	85,500,000	61,503,000	29,503,000	732,000	590,000	1,500,000	-	6,797,000	1,532,000	4.94	0.036	0.7
September, .	70,907,000	56,907,000	29,873,000	677,000	647,000	1,500,000	-	13,013,000	5,683,000	2.75	0.130	4.8
October, . .	70,003,000	64,329,000	29,987,000	652,000	848,000	2,419,000	-	5,971,000	22,261,000	3.69	0.528	14.3
November, .	115,383,000	67,543,000	34,540,000	670,000	1,073,000	10,310,000	45,867,000	-	44,620,000	4.62	1.024	22.2
December, .	79,800,000	63,287,000	35,632,000	739,000	1,252,000	20,206,000	26,987,000	-	68,303,000	3.60	1.620	45.0
Total, . .	-	-	-	-	-	-	-		-	38.38	10.804	-
Av. for year,	65,580,000	70,560,000	29,839,000	723,000	815,000	9,020,000	-	6,692,000	38,685,000	-	-	28.2

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[1] Not including 145,300 gallons per day drawn from the Wachusett Aqueduct for the supply of the Westborough Insane Hospital, which were not discharged into Sudbury Reservoir.

TABLE No. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1911.*

[Watershed of lake = 17.58 square miles.[1]]

MONTH.	GALLONS PER DAY.						Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
	Water discharged through Cochituate Aqueduct.	Water diverted from Watershed by Sewers, etc.	Water wasted at Outlet of Lake.	STORAGE.		Total Yield of Watershed.			
				Gain.	Loss.				
January,	403,000	271,000	-	8,100,000	-	8,774,000	2.74	0.89	32.3
February,	10,604,000	561,000	-	2,168,000	-	13,332,000	3.20	1.22	38.2
March,	13,658,000	623,000	-	5,448,000	-	19,729,000	3.31	2.00	60.5
April,	10,907,000	960,000	2,200,000	8,013,000	-	22,080,000	2.73	2.17	79.4
May,	-	413,000	2,271,000	165,000	-	2,848,000	0.65	0.29	44.5
June,	943,000	357,000	1,403,000	-	1,380,000	1,323,000	2.53	0.13	5.1
July,	21,903,000	145,000	-	-	21,458,000	590,000	3.42	0.06	1.8
August,	21,548,000	184,000	-	-	16,203,000	5,529,000	4.82	0.56	11.6
September,	19,063,000	320,000	-	-	13,143,000	6,240,000	2.96	0.61	20.7
October,	11,400,000	352,000	-	-	2,823,000	8,929,000	3.53	0.91	25.7
November,	1,410,000	547,000	-	10,177,000	-	12,133,000	4.28	1.19	27.8
December,	2,345,000	829,000	-	14,519,000	-	17,694,000	3.74	1.79	46.4
Total,	-	-	-	-	-	-	37.91	11.82	-
Average for year,	9,522,000	462,000	489,000	-	573,000	9,900,000	-	-	31.2

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[1] Not including the watersheds of Dudley and Dug ponds.

TABLE No. 10.— *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1911.*

[Watershed from 1875 to 1878 inclusive = 77.764 square miles; in 1879 and 1880 = 78.238 square miles; and from 1881 to 1911 inclusive = 75.2 square miles.]

MONTH.	GALLONS PER DAY.											
	Water received from Wachusett Reservoirs.[1]	Water discharged through Sudbury Aqueduct.	Water discharged through Weston Aqueduct.	Water used by Framingham Water Works.	Water diverted from Watershed by Sewers, etc.	Water wasted into River below Lowest Dam.	STORAGE.		Total Yield of Watershed.	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
							Gain.	Loss.				
January, . .	104,952,000	89,235,000	28,571,000	768,000	697,000	21,958,000	2,726,000	-	39,003,000	2.88	0.925	32.1
February, .	52,500,000	79,300,000	28,182,000	675,000	1,000,000	9,179,000	-	13,164,000	52,671,000	2.77	1.128	40.7
March, . .	38,619,000	69,365,000	28,242,000	681,000	913,000	18,284,000	7,197,000	-	86,061,000	3.59	2.042	56.9
April, . .	-	66,560,000	27,943,000	707,000	1,110,000	18,253,000	-	7,430,000	107,210,000	2.81	2.462	87.4
May, . .	27,726,000	84,087,000	28,235,000	794,000	629,000	1,503,000	-	63,623,000	23,900,000	1.01	0.567	56.1
June, . .	61,360,000	78,430,000	27,903,000	737,000	593,000	1,500,000	-	31,800,000	16,003,000	2.53	0.367	14.5
July, . .	78,535,000	66,603,000	29,323,000	842,000	445,000	1,500,000	-	21,252,000	—1,074,000	3.19	—0.025	—0.8
August, . .	85,500,000	61,503,000	29,503,000	732,000	590,000	1,500,000	-	6,797,000	1,532,000	4.94	0.036	0.7
September, .	70,907,000	56,907,000	29,873,000	677,000	647,000	1,500,000	-	13,013,000	5,683,000	2.75	0.130	4.8
October, . .	70,003,000	64,329,000	29,987,000	652,000	848,000	2,419,000	-	5,971,000	22,261,000	3.69	0.528	14.3
November, .	115,383,000	67,543,000	34,540,000	670,000	1,073,000	10,310,000	45,867,000	-	44,620,000	4.62	1.024	22.2
December, .	79,800,000	63,287,000	35,632,000	739,000	1,252,000	20,206,000	26,987,000	-	68,303,000	3.60	1.620	45.0
Total, . .	-	-	-	-	-	-	-	-	-	38.38	10.804	-
Av. for year,	65,580,000	70,560,000	29,839,000	723,000	815,000	9,020,000	-	6,692,000	38,685,000	-	-	28.2

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[1] Not including 145,300 gallons per day drawn from the Wachusett Aqueduct for the supply of the Westborough Insane Hospital, which were not discharged into Sudbury Reservoir.

TABLE No. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1911.*

[Watershed of lake = 17.58 square miles.[1]]

MONTH.	GALLONS PER DAY.						Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
	Water discharged through Cochituate Aqueduct.	Water diverted from Watershed by Sewers, etc.	Water wasted at Outlet of Lake.	STORAGE.		Total Yield of Watershed.			
				Gain.	Loss.				
January,	403,000	271,000	-	8,100,000	-	8,774,000	2.74	0.89	32.3
February,	10,604,000	561,000	-	2,168,000	-	13,332,000	3.20	1.22	38.2
March,	13,658,000	623,000	-	5,448,000	-	19,729,000	3.31	2.00	60.5
April,	10,907,000	960,000	2,200,000	8,013,000	-	22,080,000	2.73	2.17	79.4
May,	-	413,000	2,271,000	165,000	-	2,848,000	0.65	0.29	44.5
June,	943,000	357,000	1,403,000	-	1,380,000	1,323,000	2.53	0.13	5.1
July,	21,903,000	145,000	-	-	21,458,000	590,000	3.42	0.06	1.8
August,	21,548,000	184,000	-	-	16,203,000	5,529,000	4.82	0.56	11.6
September,	19,063,000	320,000	-	-	13,143,000	6,240,000	2.96	0.61	20.7
October,	11,400,000	352,000	-	-	2,823,000	8,929,000	3.53	0.91	25.7
November,	1,410,000	547,000	-	10,177,000	-	12,133,000	4.28	1.19	27.8
December,	2,345,000	829,000	-	14,519,000	-	17,694,000	3.74	1.79	46.4
Total,	-	-	-	-	-	-	37.91	11.82	-
Average for year,	9,522,000	462,000	489,000	-	573,000	9,900,000	-	-	31.2

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[1] Not including the watersheds of Dudley and Dug ponds.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

Date.	Chestnut Hill Reservoir. Ordinary High Water =134.00.	Lake Cochituate. High Water =144.36.	Farm Pond. High Water =159.25.	Spot Pond. High Water =163.00.	Weston Reservoir. High Water =200.00.	Framingham Reservoir. No. 1. Flash Boards 169.27.	Framingham Reservoir. No. 2. Flash Boards 177.12.	Framingham Reservoir. No. 3. Flash Boards 186.50.	Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Flash Boards 259.97.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. Ordinary High Water =337.91.	Wachusett Reservoir. Ordinary High Water =395.00.
Jan. 1, 1911, .	133.70	141.19	157.42	162.66	200.07	167.74	176.06	183.64	224.40	259.25	304.16	335.70	379.35
Feb. 1, 1911, .	133.76	142.33	157.59	162.66	200.05	167.68	175.99	184.42	224.43	259.12	304.17	336.08	378.72
Mar. 1, 1911, .	133.94	142.60	157.83	162.63	199.96	167.69	176.00	182.69	224.48	258.96	299.80	336.51	379.17
April 1, 1911, .	133.88	143.32	157.92	162.88	200.04	167.70	176.04	182.85	225.39	259.00	299.55	337.30	382.15
May 1, 1911, .	133.94	144.28	157.89	162.76	200.01	167.61	176.51	181.91	224.70	257.91	304.67	337.38	386.33
June 1, 1911, .	133.91	144.30	157.51	162.32	200.02	167.47	176.53	182.52	218.84	254.80	297.30	337.39	387.10
July 1, 1911, .	133.56	144.14	157.20	161.56	199.98	167.26	176.12	183.49	209.75	254.64	286.34	337.32	386.69
Aug. 1, 1911, .	132.31	141.28	156.75	162.00	200.02	166.95	171.02	183.80	192.86	255.99	272.71	337.00	384.86
Sept. 1, 1911, .	132.54	138.86	156.64	163.11	200.08	166.77	173.04	183.95	193.99	255.55	273.40	336.20	383.07
Oct. 1, 1911, .	132.22	136.74	156.46	162.80	200.02	166.68	176.62	183.97	195.15	254.84	274.14	334.64	381.67
Nov. 1, 1911, .	132.37	136.23	156.51	162.86	199.96	167.62	177.12	184.18	197.62	253.79	276.24	334.84	381.53
Dec. 1, 1911, .	134.06	137.94	156.71	162.84	199.88	167.73	177.27	184.05	202.41	256.29	280.93	335.40	381.29
Jan. 1, 1912, .	133.83	140.21	156.95	162.79	199.98	167.76	177.29	184.00	208.51	256.97	286.66	336.13	382.30

TABLE NO. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.*

From Wachusett Reservoir into the Wachusett Aqueduct.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	31	725	-	3,258.0
February,	19	423	40	1,474.3
March,	9	195	-	1,202.3
April,	-	-	-	0.0
May,	6	113	30	861.7
June,	19	393	30	1,846.1
July,	26	573	55	2,440.9
August,	27	474	23	2,655.4
September,	23	468	45	2,131.4
October,	26	311	52	2,175.0
November,	30	664	3	3,466.2
December,	27	411	34	2,478.5
Totals,	243	4,755	12	23,989.8

Total actual time, 198.13 days.
Total quantity drawn, 23,989,800,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to Weston Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	31	744	-	885.7
February,	28	672	-	789.1
March,	31	744	-	875.5
April,	30	720	-	838.3
May,	31	742	30	875.3
June,	30	720	-	837.1
July,	31	744	-	909.0
August,	31	744	-	914.6
September,	30	720	-	896.2
October,	31	744	-	929.6
November,	30	720	-	1,036.2
December,	31	744	-	1,104.6
Totals,	365	8,758	30	10,891.2

Total actual time, 364.94 days.
Total quantity drawn, 10,891,200,000 gallons.

TABLE No. 13 — *Continued.*

From Framingham Reservoir No. 2 through the Sudbury Aqueduct to Chestnut Hill Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	1	24	-	20.0
February,	28	672	-	880.9
March,	30	670	30	1,070.4
April,	30	720	-	1,287.6
May,	31	744	-	1,330.8
June,	30	720	-	1,289.0
July,	31	744	-	1,231.9
August,	1	24	-	33.0
September,	26	617	-	256.9
October,	31	744	-	309.7
November,	30	720	-	299.6
December,	31	744	-	309.3
Totals,	301	7,143	30	8,319.1

Total actual time, 297.65 days.
Total quantity drawn, 8,319,100,000 gallons.

From Framingham Reservoir No. 3 through the Sudbury Aqueduct to Chestnut Hill Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	31	744	-	2,746.3
February,	28	672	-	1,339.5
March,	31	744	-	1,079.9
April,	30	720	-	709.2
May,	31	744	-	1,275.9
June,	30	720	-	1,063.9
July,	31	744	-	832.8
August,	31	744	-	1,873.6
September,	30	720	-	1,450.3
October,	31	744	-	1,684.5
November,	30	720	-	1,726.7
December,	31	744	-	1,652.6
Totals,	365	8,760	-	17,435.2

Total actual time, 365 days.
Total quantity drawn, 17,435,200,000 gallons.

TABLE No. 13 — *Concluded.*

From Lake Cochituate through the Cochituate Aqueduct to Chestnut Hill Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	1	24	-	12.5
February,	28	672	-	296.9
March,	31	744	-	423.4
April,	22	511	-	327.2
May,	-	-	-	0.0
June,	2	48	-	28.3
July,	31	741	-	679.0
August,	31	744	-	668.0
September,	30	720	-	571.9
October,	23	552	-	353.4
November,	4	96	-	42.3
December,	7	152	30	72.7
Totals,	210	5,004	30	3,475.6

Total actual time, 208.52 days.
Total quantity drawn, 3,475,600,000 gallons.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1911 by Months.*[1]

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).	Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	104,952,000	28,571,000	89,235,000	403,000
February,	52,500,000	28,182,000	79,300,000	10,604,000
March,	38,619,000	28,242,000	69,365,000	13,658,000
April,	-	27,943,000	66,560,000	10,907,000
May,	27,726,000	28,235,000	84,087,000	-
June,	61,360,000	27,903,000	78,430,000	943,000
July,	78,535,000	29,323,000	66,603,000	21,903,000
August,	85,500,000	29,503,000	61,503,000	21,548,000
September,	70,907,000	29,873,000	56,907,000	19,063,000
October,	70,003,000	29,987,000	64,329,000	11,400,000
November,	115,383,000	34,540,000	67,543,000	1,410,000
December,	79,800,000	35,632,000	63,287,000	2,345,000
Average,	65,580,000	29,839,000	70,560,000	9,522,000

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[1] Not including quantities wasted while cleaning and repairing aqueducts.

TABLE NO. 15. — *Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill Pumping Station No. 1 for the Year 1911.*

[3 per cent. allowed for slip.]

MONTH.	ENGINE NO. 1. Total Pumping Time.		ENGINE NO. 1. Quantity pumped, corrected for Slip (Million Gallons).	ENGINE NO. 2. Total Pumping Time.		ENGINE NO. 2. Quantity pumped, corrected for Slip (Million Gallons).	Total Quantity pumped (Million Gallons).	Coal consumed in Pumping (Pounds).	Coal used in Banking (Pounds).	Ashes and Clinkers from Coal used in Pumping (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal used in Pumping.	AVERAGE LIFT (FEET). Engine No. 1.	AVERAGE LIFT (FEET). Engine No. 2.	Duty in Foot-pounds per 100 pounds of Coal used in Pumping.	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, on Basis of Plunger Displacement.
	Hrs.	Min.		Hrs.	Min.											
January,	-	-	-	329	00	112.64	112.64	201,092	35,883	22,213	11.0	560.14	-	121.37	56,630,000	58,390,000
February,	-	-	-	249	00	85.09	85.09	155,135	43,975	18,781	12.1	548.49	-	121.77	55,640,000	57,370,000
March,	-	-	-	108	00	36.21	36.21	67,453	56,677	8,147	12.1	536.82	-	120.28	53,790,000	55,460,000
April,	-	-	-	90	10	31.52	31.52	57,300	37,200	6,623	11.6	550.09	-	118.48	54,290,000	55,980,000
May,	147	20	52.75	40	10	14.41	67.16	95,015	32,200	11,528	12.1	706.84	120.26	120.52	70,840,000	73,040,000
June,	-	-	-	177	30	63.75	63.75	116,280	52,335	13,709	11.8	548.25	-	133.33	60,890,000	62,780,000
July,	-	-	-	175	10	63.54	63.54	105,050	18,730	19,774	18.8	604.85	-	135.88	68,460,000	70,590,000
August,	-	-	-	127	00	44.67	44.67	73,175	14,935	11,373	15.6	610.45	-	135.93	69,120,000	71,270,000
September,	-	-	-	114	00	40.46	40.46	69,225	11,205	10,766	15.6	584.47	-	136.14	66,280,000	68,340,000
October,	25	05	9.25	82	35	28.82	38.07	70,810	11,070	9,920	14.0	537.64	136.85	136.41	61,140,000	63,040,000
November,	126	40	43.87	-	-	-	43.87	69,610	20,130	8,712	12.5	630.23	135.26	-	71,010,000	73,220,000
December,	20	30	6.55	115	30	38.01	44.56	89,625	31,140	9,925	11.1	497.18	134.98	134.75	55,820,000	57,560,000
Total,	319	35	112.42	1,608	05	559.12	671.54	1,169,770	365,480	151,471	-	-	-	-	-	-
Average,	-	-	-	-	-	-	-	-	-	-	12.9	574.08	128.34	128.10	61,280,000	63,190,000

TABLE No. 16. — *Statement of Operation of Engine No. 4 at Chestnut Hill Pumping Station No. 1 for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed in Pumping (Pounds).	Coal used in Banking (Pounds).	Ashes and Clinkers from Coal used in Pumping (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal used in Pumping.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, on Basis of Plunger Displacement.	SUMMARY OF ENGINES NOS. 1, 2 AND 4. Total Quantity pumped, corrected for Slip (Million Gallons).	SUMMARY OF ENGINES NOS. 1, 2 AND 4. Daily Average Quantity pumped (Million Gallons).
	Hrs.	Min.											
January,	742	10	953.29	727,990	-	79,335	10.9	1,309.48	129.65	141,420,000	144,260,000	1,065.93	34.385
February,	672	00	861.54	701,770	3,118	86,099	12.3	1,227.67	130.66	133,620,000	136,310,000	946.63	33.808
March,	741	50	931.74	709,050	4,958	71,808	10.0	1,314.07	130.17	142,490,000	145,350,000	967.95	31.224
April,	644	55	800.00	617,880	8,615	72,430	11.7	1,294.75	129.88	140,080,000	142,900,000	831.52	27.751
May,	717	00	913.55	709,667	5,270	77,035	10.9	1,287.29	129.88	139,270,000	142,070,000	980.71	31.636
June,	348	45	441.40	310,677	51,055	37,930	12.2	1,420.77	119.75	141,720,000	144,570,000	505.15	16.838
July,	-	-	-	-	78,605	-	-	-	-	-	-	63.54	2.050
August,	-	-	-	-	73,435	-	-	-	-	-	-	44.67	1.441
September,	-	-	-	-	74,425	-	-	-	-	-	-	40.46	1.349
October,	-	-	-	-	53,530	-	-	-	-	-	-	38.07	1.228
November,	201	10	241.00	179,200	50,690	21,565	12.0	1,344.87	122.91	137,690,000	140,460,000	284.87	9.496
December,	558	10	662.10	472,760	18,630	57,128	12.1	1,400.50	119.56	139,480,000	142,280,000	706.66	22.795
Total,	4,626	00	5,804.62	4,428,994	422,331	503,330	-	-	-	-	-	6,476.16	-
Average,	-	-	-	-	-	-	11.4	1,310.60	127.77	139,490,000	142,290,000	-	17.743

TABLE NO. 17. — *Statement of Operation of Engine No. 12 at Chestnut Hill Pumping Station No. 2 for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed in Pumping (Pounds).	Coal used in Banking (Pounds).	Ashes and Clinkers from Coal used in Pumping (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal used in Pumping.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, on Basis of Plunger Displacement.
January,	-	-	-	-	-	-	-	-	-	-	-
February,	-	-	-	-	-	-	-	-	-	-	-
March,	27	11	21.08	25,700	4,920	3,598	14.0	820.23	127.19	86,900,000	88,660,000
April,	94	08	115.76	90,330	21,230	12,900	14.3	1,281.52	132.02	140,930,000	143,790,000
May,	55	40	66.01	57,305	20,900	5,125	8.9	1,151.91	131.36	126,050,000	128,610,000
June,	368	18	485.06	334,090	13,755	44,650	13.4	1,451.88	122.17	147,750,000	150,750,000
July,	742	20	1,038.61	728,035	-	103,630	14.2	1,426.59	124.97	148,510,000	151,520,000
August,	740	20	955.75	639,970	1,805	63,840	10.0	1,493.43	124.84	155,300,000	158,450,000
September,	715	05	902.02	597,285	-	80,850	13.5	1,510.20	124.21	156,260,000	159,430,000
October,	744	00	917.87	604,370	-	94,170	15.6	1,518.72	121.98	154,320,000	157,450,000
November,	506	45	630.48	386,770	3,465	51,980	13.4	1,630.12	118.96	161,530,000	164,810,000
December,	180	45	219.47	162,260	35,795	22,425	13.8	1,352.58	119.12	134,210,000	136,910,000
Total,	4,174	32	5,352.11	3,626,115	101,870	483,168	-	-	-	-	-
Average,	-	-	-	-	-	-	13.3	1,475.99	123.34	151,650,000	154,730,000

TABLE No. 18. — *Statement of Operation of Engines Nos. 5, 6 and 7, at Chestnut Hill Pumping Station No. 2 for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	ENGINE No. 5.			ENGINE No. 6.			ENGINE No. 7.			Total Quantity pumped (Million Gallons).	Daily Average Quantity pumped (Million Gallons).	Total Coal consumed (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	AVERAGE LIFT (FEET).			Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement; no Deduction for Heating or Lighting.
	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).						Engine No. 5.	Engine No. 6.	Engine No. 7.		
	Hrs.	Min.		Hrs.	Min.		Hrs.	Min.											
January,	696	15	756.54	707	05	771.45	173	30	208.21	1,736.20	56.006	667,175	13.2	2,602.32	50.30	50.06	22.94	101,690,000	103,770,000
February,	626	20	667.75	648	25	700.39	209	40	242.06	1,610.20	57.507	645,760	10.7	2,493.50	50.50	50.30	22.10	95,840,000	97,800,000
March,	700	50	770.82	719	40	797.32	52	10	67.01	1,635.15	52.747	653,580	14.0	2,501.84	48.08	44.58	22.96	94,500,000	96,440,000
April,	422	40	460.00	698	35	816.22	142	40	136.40	1,412.62	47.087	517,505	13.7	2,729.67	47.07	45.84	20.08	99,490,000	101,530,000
May,	457	30	486.98	744	00	814.84	269	10	284.31	1,586.13	51.165	592,960	11.5	2,681.15	54.61	55.10	21.98	109,470,000	111,710,000
June,	530	25	571.19	485	30	536.87	317	00	306.16	1,414.22	47.141	529,105	12.8	2,672.85	56.99	56.68	21.73	109,630,000	111,880,000
July,	742	10	788.40	552	50	566.96	250	25	276.91	1,632.27	52.654	636,565	13.5	2,564.18	58.49	58.04	24.50	112,280,000	114,580,000
August,	638	10	649.80	673	10	694.90	194	25	205.95	1,550.65	50.021	558,260	9.3	2,777.65	54.93	54.73	25.13	117,730,000	120,140,000
September,	193	10	195.08	720	00	874.03	277	05	255.98	1,325.09	44.170	449,000	11.5	2,951.20	50.91	47.53	22.79	106,320,000	108,500,000
October,	234	35	272.69	584	35	730.48	374	30	352.16	1,355.33	43.720	464,850	13.0	2,915.63	50.97	48.42	22.63	102,570,000	104,670,000
November,	210	50	215.90	592	55	691.85	285	15	227.06	1,134.81	37.827	440,010	11.9	2,579.06	45.68	44.16	31.53	90,060,000	91,910,000
December,	149	00	152.24	693	45	802.80	237	00	183.00	1,138.04	36.711	442,690	11.8	2,577.90	44.57	42.12	32.38	87,790,000	89,590,000
Total,	5,601	55	5,987.39	7,820	30	8,798.11	2,782	50	2,745.21	17,530.71	-	6,597,460	-	-	-	-	-	-	-
Average,	-	-	-	-	-	-	-	-	-	-	48.029	-	12.3	2,657.19	52.10	49.37	24.10	102,580,000	104,680,000

TABLE NO. 19. — *Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	13	30	5.89	6,570	1,010	15.4	896.50	122.76	91,680,000	93,570,000
February,	-	-	-	-	-	-	-	-	-	-
March,	12	00	5.05	5,227	600	11.5	966.14	124.87	100,490,000	102,560,000
April,	-	-	-	-	-	-	-	-	-	-
May,	15	30	6.79	6,250	560	9.0	1,086.40	120.44	108,990,000	111,240,000
June,	-	-	-	-	-	-	-	-	-	-
July,	-	-	-	-	-	-	-	-	-	-
August,	15	30	6.60	6,990	1,060	15.2	944.21	117.31	92,270,000	94,170,000
September,	-	-	-	-	-	-	-	-	-	-
October,	15	00	6.72	7,310	1,020	14.0	919.29	127.27	97,460,000	99,470,000
November,	-	-	-	-	-	-	-	-	-	-
December,	-	-	-	-	-	-	-	-	-	-
Total,	71	30	31.05	32,347	4,250	-	-	-	-	-
Average,	-	-	-	-	-	13.1	959.90	122.41	97,880,000	99,900,000

TABLE No. 20. — *Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal on Basis of Plunger Displacement, no Deduction for Heating or, Lighting.	SUMMARY OF ENGINES NOS. 8 AND 9.	
											Total Quantity pumped, corrected for Slip (Million Gallons).	Daily Average Quantity pumped (Million Gallons).
	Hrs.	Min.										
January,	251	20	209.17	183,986	22,069	12.0	1,136.88	130.81	123,880,000	126,390,000	215.06	6.937
February,	238	25	198.38	178,824	23,788	13.3	1,109.36	133.07	122,970,000	125,470,000	198.38	7.085
March,	247	35	205.96	185,574	23,457	12.6	1,109.85	133.31	123,250,000	125,750,000	211.01	6.807
April,	245	30	204.70	182,995	22,492	12.3	1,118.61	133.02	123,950,000	126,470,000	204.70	6.823
May,	293	25	243.78	205,874	25,661	12.5	1,184.12	130.04	128,270,000	130,870,000	250.57	8.083
June,	285	30	236.78	202,645	27,094	13.4	1,168.45	130.20	126,730,000	129,300,000	236.78	7.893
July,	354	10	294.65	242,298	34,717	14.3	1,216.06	131.68	133,390,000	136,100,000	294.65	9.505
August,	297	15	247.30	212,123	26,385	12.4	1,165.83	133.63	129,770,000	132,400,000	253.90	8.190
September,	288	45	237.04	211,280	28,559	13.5	1,121.92	136.93	127,970,000	130,570,000	237.04	7.901
October,	273	10	223.56	201,664	24,193	12.0	1,108.58	137.01	126,520,000	129,090,000	230.28	7.428
November,	261	00	215.04	198,240	26,127	13.2	1,084.75	136.72	123,540,000	126,050,000	215.04	7.168
December,	271	15	222.81	204,565	27,117	13.3	1,089.19	136.15	123,530,000	126,040,000	222.81	7.187
Total,	3,307	20	2,739.17	2,410,068	311,659	-	-	-	-	-	2,770.22	-
Average,	-	-	-	-	-	12.9	1,136.55	133.49	126,380,000	128,950,000	-	7.590

TABLE NO. 21. — *Statement of Operation of Engine No. 10 at Arlington Pumping Station for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	502	15	20.71	69,455	5,849	8.4	298.18	280.99	69,700,000	71,000,000
February,	430	15	17.60	61,520	5,358	8.7	286.09	282.67	67,360,000	68,530,000
March,	500	00	20.84	75,220	7,625	10.1	277.05	282.67	65,240,000	66,370,000
April,	378	30	15.77	56,660	5,656	10.0	278.33	283.17	65,650,000	66,790,000
May,	597	15	27.68	86,390	9,288	10.8	320.41	284.79	76,010,000	77,320,000
June,	570	50	26.46	81,850	9,658	11.8	323.27	284.43	76,590,000	77,920,000
July,	696	00	36.36	104,155	12,419	11.9	349.10	288.55	83,910,000	85,360,000
August,	641	30	30.11	89,670	11,033	12.3	335.79	284.49	79,580,000	80,960,000
September,	636	30	27.36	84,545	9,367	11.1	323.61	282.35	76,110,000	77,430,000
October,	607	00	25.46	80,260	8,816	11.0	317.22	283.02	74,790,000	76,080,000
November,	119	30	5.08	16,600	1,837	11.1	306.02	281.13	71,660,000	72,900,000
December,	309	30	12.31	44,425	4,977	11.2	277.10	282.74	65,260,000	66,300,000
Total,	5,989	05	265.74	850,750	91,883	-	-	-	-	-
Average,	-	-	-	-	-	10.8	312.36	283.05	73,880,000	75,160,000

TABLE NO. 22. — *Statement of Operation of Engine No. 11 at Arlington Pumping Station for the Year 1911.*

[4 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	Summary of Engines Nos. 10 and 11.	
	Hrs.	Min.									Total Quantity pumped, corrected for Slip (Million Gallons).	Daily Average Quantity pumped (Million Gallons).
January,	-	-	-	-	-	-	-	-	-	-	20.71	.668
February,	49	30	1.48	10,050	885	8.8	147.26	278.50	34,160,000	35,750,000	19.08	.681
March,	-	-	-	-	-	-	-	-	-	-	20.84	.672
April,	162	30	5.62	34,870	3,410	9.8	161.17	284.71	38,220,000	40,000,000	21.39	.713
May,	24	45	.86	6,035	740	12.3	142.50	286.88	34,050,000	35,630,000	28.54	.921
June,	-	-	-	-	-	-	-	-	-	-	26.46	.882
July,	3	00	.10	930	-	-	111.83	288.00	26,830,000	28,080,000	36.46	1.176
August,	-	-	-	-	-	-	-	-	-	-	30.11	.971
September,	16	45	.74	4,245	585	13.8	175.03	277.50	40,460,000	42,340,000	28.10	.937
October,	29	30	1.07	6,520	470	7.2	164.11	285.13	38,980,000	40,790,000	26.53	.856
November,	557	45	19.03	113,580	10,448	9.2	167.55	273.20	38,130,000	39,900,000	24.11	.804
December,	324	00	10.18	62,320	5,870	9.4	163.35	272.40	37,070,000	38,790,000	22.49	.726
Total,	1,167	45	39.08	238,550	22,408	-	-	-	-	-	304.82	-
Average,	-	-	-	-	-	9.4	163.82	275.60	37,610,000	39,360,000	-	.835

TABLE NO. 23. — (*Meter Basis.*) *Average Daily Consumption of Water during the Year 1911, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont and Nahant.* (*For Consumption of Water in Whole Metropolitan Water District, see Table No. 26.*)

MONTH.	Average Daily Consumption (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
January,	117,814,500	1,032,690	114
February,	118,747,700	1,034,680	115
March,	112,556,500	1,036,680	109
April,	107,358,100	1,038,670	103
May,	111,980,400	1,044,740	107
June,	109,808,800	1,047,630	104
July,	116,903,200	1,051,800	111
August,	108,391,500	1,051,470	103
September,	106,218,200	1,051,070	101
October,	104,985,400	1,051,080	100
November,	102,482,600	1,052,660	97
December,	103,083,400	1,054,670	98
For the year,	109,994,800	1,046,630	105

In addition to the above quantities, Wakefield was supplied with 83,948,700 gallons, equivalent to a daily average rate of 230,000 gallons, the United States Government Reservation on Peddocks Island with 32,598,000 gallons, equivalent to a daily average rate of 89,300 gallons, and a part of Saugus with 4,782,500 gallons, equivalent to a daily average rate of 13,100 gallons.

TABLE NO. 24. — (*Meter Basis.*) *Average Daily Consumption of Water in Gallons, from the Low-service System in 1911.*

MONTH.	SOUTHERN LOW SERVICE.	NORTHERN LOW SERVICE.	Total Low-service Consumption.
	Boston, excluding East Boston and Charlestown.	Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington.	
January,	49,576,900	26,971,800	76,548,700
February,	49,762,900	28,194,200	77,957,100
March,	47,418,400	26,208,100	73,626,500
April,	44,088,700	24,434,800	68,523,500
May,	45,304,200	25,115,400	70,419,600
June,	43,757,700	24,990,700	68,748,400
July,	45,702,300	26,005,000	71,707,300
August,	43,653,900	24,914,100	68,568,000
September,	43,433,500	24,101,900	67,535,400
October,	43,518,200	23,137,800	66,656,000
November,	44,171,400	21,613,900	65,785,300
December,	44,878,100	21,308,100	66,186,200
For the year,	45,420,600	24,731,900	70,152,500

TABLE No. 25. — *(Meter Basis.) Average Daily Consumption of Water, in Gallons, from the High-service and Extra High-service Systems in 1911.*

MONTH.	SOUTHERN HIGH SERVICE.	SOUTHERN EXTRA HIGH SERVICE.	NORTHERN HIGH SERVICE.	NORTHERN EXTRA HIGH SERVICE.
	Quincy, Watertown, and Portions of Boston, Belmont and Milton.	Portions of Boston and Milton.	Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford and Somerville.	Lexington and Portions of Arlington and Belmont.
January,	33,171,700	625,400	6,800,500	668,200
February,	32,469,000	635,100	7,005,100	681,400
March,	30,870,100	640,100	6,747,500	672,300
April,	30,613,300	646,200	6,862,200	712,900
May,	31,936,200	770,400	7,933,500	920,700
June,	31,480,600	738,500	7,959,300	882,000
July,	33,699,700	880,700	9,439,200	1,176,300
August,	30,255,300	685,000	7,911,600	971,600
September,	29,688,900	660,800	7,396,500	936,600
October,	29,811,300	674,900	6,987,400	855,800
November,	28,483,300	655,000	6,755,400	803,600
December,	28,737,500	661,300	6,772,800	725,600
For the year,	30,931,600[1]	690,100	7,385,500[2]	835,100

In addition to the above [1] the United States Government Reservation on Peddocks Island was supplied with a daily average rate of 89,300 gallons, and [2] part of Saugus with a daily average rate of 13,100 gallons, and Wakefield with a daily average rate of 230,000 gallons.

TABLE No. 26. — *Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venturi Meters in 1911.*

City or town,	BOSTON.		SOMERVILLE.		MALDEN.		CHELSEA.		EVERETT.		QUINCY.		MEDFORD.	
Population supplied,	**688,520.**		**79,360.**		**45,780.**		**33,630.**		**34,910.**		**33,760.**		**24,100.**	
MONTH.	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	93,790,600	138	6,226,000	79	1,815,900	40	2,875,100	87	2,789,100	81	2,633,000	79	1,223,400	52
February,	94,230,900	138	6,396,700	81	1,821,300	40	2,999,200	90	2,849,300	83	2,650,600	79	1,210,800	51
March,	89,108,000	130	6,083,600	77	1,793,400	39	2,812,300	85	2,544,900	74	2,604,500	78	1,194,700	50
April,	84,096,900	123	5,923,900	75	1,866,500	41	2,642,400	79	2,459,100	71	2,595,500	77	1,211,600	51
May,	85,982,400	125	6,172,000	78	2,081,200	46	2,726,800	82	2,655,700	77	3,107,300	92	1,362,900	57
June,	84,296,300	123	6,076,600	77	1,970,600	43	2,635,000	79	2,559,300	74	3,163,400	94	1,294,100	54
July,	88,015,600	128	6,186,300	78	2,252,800	49	2,796,500	83	2,842,400	81	3,598,700	107	1,448,200	60
August,	82,764,100	120	5,873,600	74	2,013,100	44	2,736,000	81	2,592,700	74	3,223,500	95	1,222,400	51
September,	82,105,000	119	5,611,500	70	2,008,900	44	2,687,200	79	2,434,700	69	3,124,600	92	1,091,900	45
October,	81,838,500	118	5,510,800	69	2,032,100	44	2,569,700	76	2,372,900	67	2,938,100	86	1,086,000	45
November,	80,108,600	116	5,326,600	67	2,001,200	43	2,481,800	73	2,267,500	64	2,863,200	84	1,094,800	45
December,	80,982,200	117	5,428,400	68	1,983,200	43	2,471,800	73	2,338,200	66	2,577,000	76	1,040,800	43
For the year,	85,571,500	124	5,899,100	74	1,971,300	43	2,701,400	80	2,557,800	73	2,925,400	87	1,207,100	50

Table No. 26. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

City or town,	Melrose.		Revere.		Watertown.		Arlington.		Milton.		Winthrop.	
Population supplied,	16,070.		19,240.		13,330.		11,700.		8,140.		10,670.	
Month.	Gallons.		Gallons.		Gallons.		Gallons.		Gallons.		Gallons.	
	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	935,100	59	1,386,500	73	952,200	72	827,000	72	264,000	33	512,100	49
February,	963,300	60	1,430,300	76	827,300	63	827,600	72	287,800	36	519,300	49
March,	939,000	59	1,281,400	67	851,200	64	818,700	71	305,100	38	486,500	46
April,	958,400	60	1,230,900	65	870,000	66	856,800	74	345,000	43	523,700	50
May,	1,087,500	68	1,468,100	77	970,500	73	1,192,000	102	405,800	50	650,600	61
June,	1,036,100	65	1,541,600	80	906,800	68	1,087,200	93	335,700	41	690,900	65
July,	1,141,900	71	1,772,400	92	1,092,600	82	1,484,300	127	356,800	44	911,500	85
August,	989,300	61	1,618,200	84	895,000	67	1,106,100	94	290,300	36	777,900	73
September,	1,041,700	65	1,496,400	77	830,000	62	999,100	85	297,600	36	608,500	57
October,	1,058,100	66	1,366,300	70	844,600	63	924,300	78	320,000	39	513,400	48
November,	997,400	62	1,313,500	67	819,800	61	833,500	70	314,100	38	484,300	45
December,	996,500	62	1,361,100	70	800,700	59	821,700	69	287,500	35	484,200	45
For the year,	1,012,500	63	1,439,400	75	889,200	67	983,200	84	317,700	39	597,800	56

TABLE No. 26. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

City or town,	STONEHAM.		BELMONT.		LEXINGTON.		NAHANT.		SWAMPSCOTT.		METROPOLITAN DISTRICT.	
Population supplied,	7,360.		5,840.		4,590.[1]		2,340.[2]		7,290.[2]		1,046,630.	
	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
MONTH.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	594,700	82	295,400	52	283,500	63	60,400	49	350,500	55	117,814,500	114
February,	747,400	103	310,400	54	291,400	64	60,700	49	323,400	51	118,747,700	115
March,	727,200	100	333,300	58	292,400	64	60,400	49	319,900	50	112,556,500	109
April,	689,700	94	351,200	61	305,700	67	72,800	58	358,000	56	107,358,100	103
May,	520,100	71	517,600	89	373,400	82	190,400	61	516,100	60	111,980,400	107
June,	565,700	77	500,700	86	366,800	80	255,500	67	526,500	60	109,808,800	104
July,	622,300	85	745,700	128	525,600	115	436,800	84	672,800	70	116,903,200	111
August,	518,000	70	499,800	85	428,500	93	283,100	71	559,900	66	108,391,500	103
September,	507,200	69	376,400	64	375,000	81	181,800	65	440,700	60	106,218,200	101
October,	464,900	63	352,200	60	344,500	75	102,900	61	346,100	54	104,985,400	100
November,	460,100	62	356,000	60	355,200	77	62,000	48	343,000	53	102,482,600	97
December,	477,100	64	334,800	56	286,900	62	46,800	36	364,500	57	103,083,400	98
For the year,	573,300	78	415,500	71	352,900	77	152,000	65	427,700	59	109,994,800	105

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[1] Allowance made for district not supplied.

[2] Allowance for summer population.

TABLE NO. 27. — *(Pump Basis.) Consumption of Water in the Metropolitan Water District, as constituted in the Year 1911, and a Small Section of the Town of Saugus, from 1893 to 1911.*

[Gallons per day.]

MONTH.	1893.	1894.	1895.	1896.	1897.
January,	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000
February,	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000
March,	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000
April,	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000
May,	61,025,000	60,676,000	65,194,000	73,402,000	76,772,000
June,	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000
July,	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000
August,	66,983,000	67,995,000	72,233,000	78,537,000	84,103,000
September,	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000
October,	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000
November,	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000
December,	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000
Average,	66,165,000	65,382,000	69,499,000	78,360,000	80,793,000
Population,	723,153	743,354	763,557	786,385	809,213
Per capita,	91.5	88.0	91.0	99.7	99.8

MONTH.	1898.	1899.	1900.	1901.	1902.
January,	83,880,000	96,442,000	100,055,000	111,275,000	118,435,000
February,	87,475,000	103,454,000	98,945,000	117,497,000	117,268,000
March,	85,468,000	90,200,000	97,753,000	105,509,000	108,461,000
April,	76,574,000	86,491,000	89,497,000	93,317,000	103,153,000
May,	76,677,000	89,448,000	87,780,000	95,567,000	106,692,000
June,	83,463,000	97,691,000	98,581,000	103,420,000	110,002,000
July,	88,228,000	96,821,000	107,786,000	106,905,000	108,340,000
August,	87,558,000	92,072,000	102,717,000	102,815,000	107,045,000
September,	88,296,000	91,478,000	103,612,000	102,103,000	107,752,000
October,	81,770,000	89,580,000	98,358,000	103,389,000	106,560,000
November,	78,177,000	86,719,000	93,648,000	101,324,000	105,175,000
December,	86,355,000	85,840,000	97,844,000	113,268,000	125,434,000
Average,	83,651,000	92,111,000	98,059,000	104,645,000	110,345,000
Population,	832,042	854,870	877,698	892,740	907,780
Per capita,	100.5	107.8	111.7	117.2	121.6

TABLE NO. 27. — (*Pump Basis.*) *Consumption of Water, etc.* — Concluded.

[Gallons per day.]

MONTH.	1903.	1904.	1905.	1906.	1907.
January,	125,176,000	137,771,000	130,878,000	126,093,000	137,730,000
February,	122,728,000	143,222,000	140,595,000	130,766,000	150,822,000
March,	111,977,000	123,334,000	120,879,000	123,570,000	134,202,000
April,	107,179,000	108,688,000	111,898,000	118,428,000	121,556,000
May,	111,589,000	111,715,000	115,804,000	122,404,000	123,502,000
June,	105,590,000	111,209,000	117,441,000	121,882,000	125,623,000
July,	107,562,000	113,584,000	124,769,000	118,726,000	128,779,000
August,	103,570,000	112,836,000	121,158,000	120,591,000	131,098,000
September,	106,772,000	114,188,000	120,103,000	121,685,000	124,751,000
October,	103,602,000	108,290,000	118,301,000	116,561,000	124,051,000
November,	103,477,000	108,054,000	116,693,000	113,746,000	119,627,000
December,	114,721,000	125,119,000	122,696,000	130,995,000	122,407,000
Average,	110,277,000	118,114,000	121,671,000	122,085,000	128,561,000
Population,	922,820	937,860	955,920	981,690	1,007,520
Per capita,	119.5	125.9	127.3	124.4	127.6

MONTH.	1908.	1909.	1910.	1911.
January,	132,376,000	133,275,000	127,568,000	123,281,000
February,	146,199,000	130,763,000	131,093,000	124,359,000
March,	128,884,000	126,842,000	117,078,000	116,669,000
April,	128,926,000	125,335,000	112,775,000	111,656,000
May,	131,040,000	123,305,000	112,073,000	118,095,000
June,	139,843,000	125,179,000	114,082,000	114,145,000
July,	138,232,000	126,765,000	122,743,000	123,052,000
August,	128,073,000	121,781,000	118,373,000	111,091,000
September,	129,972,000	118,043,000	112,434,000	108,726,000
October,	124,189,000	115,939,000	112,332,000	106,873,000
November,	117,119,000	111,664,000	107,528,000	105,373,000
December,	124,468,000	115,733,000	121,994,000	104,592,000
Average,	130,712,000	122,851,000	117,458,000	113,951,000
Population,	1,025,890	1,051,420	1,076,930	1,102,210
Per capita,	127.4	116.8	109.1	103.4

This table includes the water consumed in the cities and towns enumerated in Table No. 23, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District, but have not been supplied from the Metropolitan Works. The populations for the years 1901 to 1909 were revised after the census of 1905 and of 1910 became available, and consequently the figures in the reports after 1904 and 1909 differ from those published in a corresponding table in the preceding annual reports.

TABLE No. 28. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
				COLOR.						ALBUMINOID.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1911.																
90125	Jan. 3	None.	V. slight.	9	V. faintly vegetable.	Faintly vegetable.	3.95	1.60	.0018	.0094	.0084	.0010	.30	.0020	.0000	.22	0.8
90415	Jan. 17	None.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	2.15	1.05	.0022	.0108	.0088	.0020	.27	.0000	.0000	.15	0.8
90649	Jan. 31	None.	None.	8	V. faintly vegetable.	Faintly vegetable.	2.80	1.35	.0016	.0088	.0070	.0018	.25	.0010	.0000	.20	0.8
90923	Feb. 14	None.	V. slight.	10	None.	V. faintly vegetable.	–	–	.0020	.0086	.0074	.0012	.26	.0010	.0000	.23	0.8
91238	Mar. 7	V. slight.	V. slight.	8	V. faintly vegetable.	Faintly vegetable.	2.75	1.30	.0024	.0100	.0080	.0020	.26	.0020	.0000	.22	0.8
91514	Mar. 21	None.	V. slight.	10	Faintly unpleasant.	Distinctly unpleasant and fishy.	2.60	1.15	.0020	.0106	.0082	.0024	.27	.0020	.0000	.25	0.8
91769	Apr. 4	V. slight.	V. slight.	2	Faintly unpleasant.	Distinctly unpleasant and fishy.	3.60	1.70	.0016	.0132	.0126	.0006	.25	.0010	.0000	.21	0.8
92054	Apr. 18	V. slight.	Slight.	2	Faintly unpleasant.	Distinctly unpleasant.	2.55	1.00	.0014	.0092	.0084	.0008	.27	.0010	.0000	.24	0.8
92298	May 2	V. slight.	Slight.	10	V. faintly vegetable.	Faintly vegetable.	3.00	1.20	.0008	0134	.0096	.0038	.26	.0010	.0000	.24	0.8
92527	May 16	V. slight.	Slight.	12	V. faintly vegetable.	V. faintly vegetable.	2.30	1.00	.0018	.0114	.0096	.0018	.27	.0010	.0000	.25	0.8
92891	June 6	V. slight.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	3.85	1.55	.0020	.0114	.0102	.0012	.26	.0010	.0000	.26	1.0
93199	June 20	V. slight.	Slight and organisms.	11	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	3.40	1.25	.0008	.0142	.0106	.0036	.28	.0000	.0000	.27	1.1
93540	July 4	V. slight.	V. slight.	10	V. faintly vegetable.	V. faintly vegetable.	2.60	0.85	.0022	.0122	.0104	.0018	.23	.0000	.0000	.31	1.0
93867	July 18	V. slight.	V. slight.	11	None.	V. faintly vegetable.	4.20	2.35	.0008	.0094	.0062	.0032	.25	.0000	.0000	.24	1.1
94201	Aug. 1	Slight.	Slight.	13	V. faintly vegetable.	Faintly vegetable.	2.95	1.45	.0008	.0108	.0090	.0018	.27	.0000	.0000	.25	1.1
94525	Aug. 15	V. slight.	V. slight.	10	V. faintly vegetable.	V. faintly vegetable.	2.80	1.05	.0012	.0114	.0096	.0018	.30	.0000	.0000	.25	0.8
94926	Sept. 5	V. slight.	V. slight.	6	V. faintly vegetable.	Faintly vegetable.	2.85	1.05	.0010	.0134	.0128	.0006	.28	.0000	.0000	.37	1.0
95238	Sept. 19	None.	V. slight.	10	V. faintly vegetable.	V. faintly vegetable.	3.15	1.20	.0008	.0110	0104	.0006	.27	.0000	.0000	.25	0.8
95573	Oct. 3	V. slight.	V. slight.	9	Faintly vegetable.	Faintly vegetable.	2.90	1.00	.0014	.0124	.0118	.0006	.26	.0000	.0000	.22	0.8
95868	Oct. 17	V. slight.	V. slight.	5	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.15	1.05	.0014	.0110	.0102	.0008	.28	.0010	.0000	.25	0.8
96176	Oct. 31	V. slight.	V. slight.	10	Faintly vegetable.	Distinctly vegetable.	2.80	1.00	.0010	.0106	.0084	.0022	.27	.0010	.0000	.16	1.3
96584	Nov. 21	None.	V. slight.	10	Faintly vegetable.	Faintly vegetable.	2.65	0.80	.0014	.0108	.0088	.0020	.29	.0010	.0000	.22	1.3
96885	Dec. 5	V. slight.	V. slight.	9	V. faintly vegetable.	Faintly vegetable.	3.65	1.50	.0024	.0134	.0128	.0006	.31	.0010	.0000	.20	1.3
97190	Dec. 19	None.	V. slight.	8	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	2.80	0.85	.0018	.0100	.0098	.0002	.30	.0010	.0000	.16	1.3
Av.	....	....	....	9	....	....	3.02	1.23	.0015	.0111	.0096	.0016	.27	.0008	.0000	.23	0.9

TABLE No. 29. — *Chemical Examinations of Water from the Sudbury Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				Nitrates.	Nitrites.		
				Platinum Standard.						Total.	Dissolved.	Suspended.					
	1911.																
90103	Jan. 2	None.	V. slight.	8	None.	V. faintly vegetable.	3.00	1.50	.0018	.0108	.0084	.0024	.26	.0010	.0000	.22	0.8
90619	Jan. 30	Slight.	Slight.	8	V. faintly vegetable.	Faintly vegetable.	3.10	1.20	.0022	.0112	.0100	.0012	.29	.0030	.0000	.28	0.8
91202	Mar. 6	V. slight.	V. slight.	10	Faintly vegetable.	Faintly vegetable.	3.20	1.35	.0014	.0106	-	-	.31	.0040	.0000	.24	1.3
91734	Apr. 3	Slight.	Slight.	10	Faintly unpleasant.	Distinctly unpleasant and fishy.	3.10	1.20	.0024	.0160	.0112	.0048	.29	.0020	.0000	.24	1.3
92319	May 3	V. slight.	Slight.	9	V. faintly vegetable.	Faintly vegetable.	4.20	1.05	.0020	.0188	.0128	.0060	.34	.0030	.0001	.25	1.3
92850	June 5	V. slight.	V. slight.	15	Faintly vegetable.	Faintly vegetable.	4.05	1.05	.0030	.0128	.0126	.0002	.35	.0040	.0000	.29	1.8
93506	July 3	V. slight.	Slight.	11	Faintly unpleasant.	Distinctly unpleasant and organisms.	4.20	1.40	.0034	.0146	.0124	.0022	.34	.0000	.0000	.25	1.6
94150	July 31	Slight.	Slight.	12	V. faintly vegetable.	V. faintly vegetable.	3.50	0.85	.0022	.0138	.0106	.0032	.32	.0000	.0000	.24	1.1
94913	Sept. 5	V. slight.	V. slight.	10	Faintly vegetable.	Distinctly vegetable.	3.50	1.35	.0012	.0136	.0126	.0010	.27	.0000	.0001	.30	1.1
95526	Oct. 2	V. slight.	V. slight.	10	Faintly vegetable.	Faintly vegetable.	3.15	1.00	.0016	.0162	.0138	.0024	.30	.0000	.0000	.18	1.1
96227	Nov. 6	V. slight.	V. slight.	8	Faintly vegetable.	Faintly vegetable.	3.30	1.25	.0020	.0160	.0142	.0018	.29	.0010	.0000	.08	1.3
96835	Dec. 4	V. slight.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	2.95	1.20	.0024	.0126	.0106	.0020	.32	.0020	.0000	.18	1.3
Av.	....	....	....	10	....	....	3.44	1.20	.0021	.0139	.0117	.0025	.31	.0017	.0000	.23	1.2

TABLE No. 30. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
				Color.						Albuminoid.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1911.																
90115	Jan. 3	V. slight.	V. slight.	6	V. faintly vegetable.	Faintly vegetable.	3.15	1.55	.0012	.0144	.0108	.0036	.35	.0010	.0000	.23	1.3
90606	Jan. 30	Slight.	Slight.	8	V. faintly vegetable and sweetish.	Faintly vegetable and sweetish.	3.65	1.10	.0022	.0128	.0114	.0014	.36	.0010	.0000	.24	0.8
91187	Mar. 6	V. slight.	Slight.	12	Faintly unpleasant.	Faintly unpleasant.	3.40	1.25	.0030	.0148	.0124	.0024	.35	.0020	.0000	.25	1.3
91756	Apr. 4	V. slight.	Slight.	11	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.35	1.15	.0018	.0154	.0112	.0042	.36	.0010	.0000	.26	1.3
92280	May 2	Slight.	Slight.	10	V. faintly unpleasant.	Faintly unpleasant.	3.55	1.30	.0008	.0144	.0122	.0022	.36	.0020	.0000	.38	1.3
92871	June 6	V. slight.	Slight.	17	None.	V. faintly unpleasant.	3.55	1.55	.0018	.0094	.0084	.0010	.36	.0010	.0001	.32	1.4
93489	July 3	None.	V. slight.	18	Faintly vegetable.	Faintly vegetable and unpleasant.	3.50	0.90	.0006	.0136	.0118	.0018	.35	.0000	.0000	.31	1.3
94243	Aug. 2	Slight.	Slight.	16	V. faintly vegetable.	V. faintly vegetable.	3.90	1.00	.0022	.0116	.0108	.0008	.37	.0000	.0000	.35	1.6
95193	Sept. 15	V. slight.	V. slight.	11	V. faintly vegetable.	Faintly vegetable.	3.70	1.20	.0030	.0146	.0132	.0014	.40	.0000	.0000	.25	1.9
95578	Oct. 4	V. slight.	Slight.	16	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	3.50	1.00	.0024	.0218	.0136	.0082	.40	.0010	.0000	.22	1.6
96148	Oct. 30	V. slight.	V. slight.	10	Faintly unpleasant.	Distinctly unpleasant and fishy.	3.60	1.20	.0016	.0158	.0138	.0020	.39	.0010	.0000	.32	1.3
96862	Dec. 5	V. slight.	V. slight.	10	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	3.75	1.05	.0012	.0144	.0130	.0014	.40	.0010	.0000	.22	1.7
Av.	....	....	....	12	....	....	3.55	1.19	.0018	.0144	.0119	.0025	.37	.0009	.0000	.28	1.4

TABLE NO. 31. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				Nitrates.	Nitrites.		
				Platinum Standard.						Total.	Dissolved.	Suspended.					
	1911.																
90167	Jan. 2	V. slight.	V. slight.	13	Distinctly unpleasant, decaying organisms.	Decidedly unpleasant, decaying organisms.	5.80	2.00	.0016	.0196	.0152	.0044	.59	.0000	.0002	.36	2.0
90748	Feb. 6	V. slight.	V. slight.	15	V. faintly vegetable.	Faintly vegetable.	5.75	1.85	.0024	.0212	.0152	.0060	.65	.0000	.0000	.34	2.2
91212	Mar. 6	Slight.	Slight.	12	Faintly unpleasant, decaying organisms.	Distinctly unpleasant, decaying organisms.	5.70	2.20	.0032	.0186	.0148	.0038	.63	.0010	.0000	.31	2.2
91785	Apr. 3	V. slight.	Slight.	14	Distinctly unpleasant.	Distinctly unpleasant.	5.00	2.25	.0020	.0178	.0150	.0028	.59	.0030	.0000	.46	2.2
92266	May 1	Slight.	Slight.	14	Faintly unpleasant.	Distinctly unpleasant.	5.55	1.60	.0012	.0232	.0164	.0068	.65	.0000	.0001	.30	2.2
92843	June 5	V. slight.	Slight.	12	Faintly unpleasant.	Distinctly unpleasant.	5.85	2.15	.0016	.0206	.0164	.0042	.66	.0010	.0001	.33	2.5
93500	July 3	V. slight.	Slight.	15	Faintly unpleasant.	Distinctly unpleasant.	6.30	2.30	.0036	.0178	.0160	.0018	.68	.0000	.0000	.42	2.6
94166	July 31	V. slight.	Slight.	16	V. faintly vegetable.	Faintly vegetable.	6.30	2.05	.0018	.0184	.0158	.0026	.66	.0000	.0000	.36	2.7
94916	Sept. 5	V. slight.	V. slight.	11	V. faintly unpleasant.	Faintly unpleasant.	6.50	1.95	.0014	.0204	.0178	.0026	.72	.0000	.0002	.29	2.7
95558	Oct. 2	V. slight.	Slight.	12	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	6.15	1.70	.0008	.0200	.0172	.0028	.72	.0000	.0000	.38	2.7
96240	Nov. 6	V. slight.	Considerable.	10	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	6.40	1.80	.0002	.0216	.0150	.0066	.70	.0000	.0000	.29	2.5
96830	Dec. 4	Slight.	Considerable.	10	Distinctly vegetable.	Distinctly vegetable.	6.45	1.75	.0008	.0248	.0148	.0100	.70	.0000	.0000	.30	2.7
Av.	....	....	....	13	....	....	5.98	1.97	.0017	.0203	.0158	.0045	.67	.0004	.0001	.35	2.4

TABLE No. 32. — *Chemical Examinations of Water from a Tap at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				Nitrates.	Nitrites.		
				Platinum Standard.						Total.	Dissolved.	Suspended.					
	1911.																
90111	Jan. 3	None.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	3.50	1.55	.0024	.0104	.0094	.0010	.28	.0030	.0000	.18	0.8
90599	Jan. 30	V. slight.	Slight.	9	Distinctly geranium, Asterionella.	Distinctly geranium, Asterionella.	3.70	1.70	.0014	.0128	.0082	.0046	.29	.0040	.0000	.21	0.8
91184	Mar. 6	V. slight.	V. slight.	25	Distinctly geranium.	Distinctly vegetable and faintly unpleasant.	3.80	1.60	.0016	.0132	.0110	.0022	.42	.0050	.0000	.36	1.7
91718	Apr. 3	Slight.	Slight.	32	Faintly vegetable.	Distinctly vegetable.	4.80	1.90	.0020	.0172	.0146	.0026	.41	.0030	.0000	.36	1.6
92262	May 1	Slight.	Slight.	45	Distinctly vegetable.	Decidedly vegetable.	4.40	1.60	.0022	.0214	.0162	.0052	.39	.0020	.0001	.55	1.3
92854	June 6	V. slight.	Slight.	35	Faintly vegetable.	Faintly vegetable.	3.80	1.35	.0020	.0186	.0150	.0036	.36	.0040	.0001	.51	1.1
93480	July 3	V. slight.	V. slight.	47	Faintly vegetable.	Distinctly vegetable.	4.25	2.25	.0008	.0200	.0162	.0038	.39	.0030	.0001	.62	1.4
94124	July 31	Slight.	Slight.	32	Faintly vegetable.	Faintly vegetable.	4.55	1.45	.0014	.0152	.0124	.0028	.41	.0000	.0000	.40	1.8
94899	Sept. 5	V. slight.	V. slight.	9	Faintly vegetable.	Distinctly vegetable.	3.90	1.50	.0002	.0120	.0102	.0018	.38	.0020	.0000	.15	1.4
95514	Oct. 2	V. slight.	V. slight.	13	Faintly vegetable.	Distinctly vegetable.	4.00	1.15	.0014	.0156	.0144	.0012	.36	.0020	.0000	.29	1.4
96225	Nov. 6	V. slight.	V. slight.	17	None.	None.	4.30	1.70	.0010	.0140	.0130	.0010	.35	.0020	.0000	.24	1.6
96811	Dec. 4	V. slight.	Slight.	20	V. faintly vegetable.	Faintly vegetable.	5.15	2.15	.0014	.0170	.0126	.0044	.47	.0050	.0001	.28	2.0
Av.	....	....	....	25	....	....	4.18	1.66	.0015	.0156	.0128	.0029	.38	.0029	.0000	.33	1.4

TABLE No. 33. — *Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1911.*

[Parts per 100,000.]

LOCALITY.	Samples collected.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
						ALBUMINOID.							
		Platinum Standard.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
Quinepoxet River, Holden,	Semi-monthly,	43	4.22	1.69	.0023	.0171	.0152	.0019	.43	.0035	.0001	.57	1.0
Stillwater River, Sterling,	Semi-monthly,	35	3.64	1.45	.0022	.0143	.0163	.0021	.25	.0017	.0001	.44	1.0
Wachusett Reservoir, West Boylston,	Semi-monthly,	27	3.47	1.36	.0020	.0146	.0119	.0027	.30	.0022	.0001	.41	1.0
Wachusett Reservoir, Clinton, surface,	Semi-monthly,	9	3.02	1.23	.0015	.0111	.0096	.0016	.27	.0008	.0000	.23	0.9
Wachusett Reservoir, Clinton, bottom,	Semi-monthly,	10	2.95	1.17	.0021	.0097	.0085	.0011	.27	.0016	.0000	.23	0.9
Marlborough (Walker's Brook),[1]	Monthly,	61	22.64	6.31	.5776	.0544	.0391	.0154	3.78	.1089	.0111	.84	7.6
Marlborough Brook filter-beds, effluent,[2]	Monthly,	10	20.86	–	.0335	.0130	–	–	2.65	.3929	.0068	–	7.0
Wachusett Aqueduct, Southborough,[3]	Monthly,	11	3.25	1.30	.0025	.0117	.0101	.0019	.28	.0020	.0000	.26	1.1
Sudbury Reservoir, surface,	Monthly,	10	3.44	1.20	.0021	.0139	.0117	.0025	.31	.0017	.0000	.23	1.2
Sudbury Reservoir, bottom,	Monthly,	10	3.47	1.28	.0028	.0129	.0107	.0021	.31	.0017	.0000	.24	1.2
Framingham Reservoir No. 3, inlet,	Monthly,	11	3.44	1.23	.0033	.0122	.0102	.0020	.30	.0043	.0001	.25	1.4
Framingham Reservoir No. 3, near dam,	Monthly,	11	3.41	1.36	.0033	.0145	.0113	.0033	.29	.0014	.0000	.28	1.3
Hopkinton Reservoir, inlet,	Monthly,	140	7.32	3.73	.0044	.0360	.0332	.0043	.54	.0019	.0001	1.48	1.9
Hopkinton Reservoir, surface,	Monthly,	43	4.27	1.63	.0026	.0184	.0166	.0018	.41	.0015	.0000	.57	1.3
Hopkinton Reservoir, bottom,	Monthly,	47	4.52	2.01	.0035	.0182	.0167	.0015	.43	.0022	.0000	.63	1.3
Ashland Reservoir, inlet,	Monthly,	105	5.63	2.69	.0038	.0325	.0254	.0070	.41	.0043	.0001	1.21	1.6
Ashland Reservoir, surface,	Monthly,	48	4.25	1.77	.0025	.0225	.0190	.0035	.37	.0017	.0000	.64	1.3
Ashland Reservoir, bottom,	Monthly,	51	4.30	1.86	.0041	.0188	.0192	.0035	.37	.0025	.0000	.66	1.5
Framingham Reservoir No. 2, inlet,[1]	Monthly,	90	6.09	2.72	.0050	.0304	.0265	.0040	.46	.0046	.0001	1.07	1.6
Framingham Reservoir No. 2, near dam,	Monthly,	66	5.16	2.34	.0043	.0250	.0225	.0025	.43	.0032	.0001	.82	1.3
Lake Cochituate, surface,	Monthly,	13	5.98	1.97	.0017	.0203	.0158	.0045	.67	.0004	.0001	.35	2.4
Lake Cochituate, bottom,[1]	Monthly,	51	6.45	2.37	.0275	.0234	.0167	.0067	.65	.0005	.0001	.41	2.5
Weston Reservoir,[4]	Monthly,	10	3.28	1.13	.0022	.0135	.0112	.0023	.30	.0011	.0000	.25	1.4
Terminal chamber, Sudbury Aqueduct,	Monthly,	27	3.87	1.53	.0026	.0162	.0134	.0028	.33	.0017	.0000	.40	1.3
Spot Pond,	Monthly,	12	3.55	1.19	.0018	.0144	.0119	.0025	.37	.0009	.0000	.28	1.4
Tap in Revere,	Monthly,	18	3.42	1.28	.0018	.0136	.0114	.0022	.33	.0007	.0000	.23	1.3
Tap at State House,	Monthly,	25	4.18	1.66	.0015	.0156	.0128	.0029	.38	.0029	.0000	.33	1.4
Tap in Quincy,	Monthly,	21	4.02	1.63	.0014	.0135	.0122	.0012	.38	.0033	.0001	.32	1.6

[1] Average of 11 samples.
[2] Average of 7 samples.
[3] Average of 10 samples.
[4] Average of 9 samples.

TABLE NO. 34. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1911.*

[Parts per 100,000.]

YEAR.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
	Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				Nitrates.	Nitrites.		
						Total.	Dissolved.	Suspended.					
1892, . .	.37	37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	-	1.9
1893, . .	.61	53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
1894, . .	.69	58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
1895, . .	.72	59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
1896, . .	.49	45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
1897, . .	.65	55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6
1898, . .	.41	40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4
1899, . .	.23	28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.0137	.0001	.35	1.1
1900, . .	.24	29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.0076	.0001	.38	1.3
1901, . .	.24	29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.0173	.0001	.42	1.7
1902, . .	.26	30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.0092	.0000	.40	1.3
1903, . .	.25	29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.0142	.0001	.39	1.5
1904, . .	-	23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37	1.5
1905, . .	-	24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.0083	.0001	.35	1.4
1906, . .	-	24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.0054	.0001	.36	1.3
1907, . .	-	22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.0068	.0001	.32	1.3
1908, . .	-	19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.0092	.0001	.26	1.2
1909, . .	-	18	3.46	1.43	.0011	.0128	.0103	.0025	.28	.0034	.0000	.25	1.3
1910, . .	-	14	3.05	1.24	.0013	.0118	.0102	.0016	.28	.0030	.0000	.22	1.1
1911, . .	-	25	4.18	1.66	.0015	.0156	.0128	.0029	.38	.0029	.0000	.33	1.4

Note relating to Chemical Examinations of Water, Tables Nos. 28–34.

The chemical examinations contained in the tables were made by the State Board of Health. Previous to the year 1904 colors were determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The important samples are collected and examined semi-monthly or monthly.

TABLE NO. 35. — *Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1911, inclusive.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WACHUSETT RESERVOIR.		SUDBURY RESERVOIR.		LAKE COCHITUATE.		FRAMINGHAM RESERVOIR. No. 3.	FRAMINGHAM RESERVOIR. No. 2.	ASHLAND RESERVOIR.	HOPKINTON RESERVOIR.	WHITEHALL RESERVOIR.
	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	Surface.	Mid-depth.	Surface.	Surface.	Surface.
1898,	-	-	354	149	830	696	390	245	263	944	690
1899,	-	-	470	252	905	644	440	218	357	715	393
1900,	-	-	498	361	1,758	1,071	645	365	390	980	437
1901,	-	-	337	225	992	702	336	149	244	450	705
1902,	-	-	590	402	1,071	730	627	204	550	588	198
1903,	-	-	549	388	931	795	459	169	323	231	327
1904,	313	-	517	376	663	542	475	174	153	106	375
1905,	769	592	644	502	1,255	503	535	158	280	240	147
1906,	446	272	953	714	1,407	1,143	692	226	431	475	1,270
1907,	425	212	513	419	1,123	1,200	413	205	378	336	961
1908,	731	466	850	885	1,559	1,241	932	725	690	516	708
1909,	2,151	1,937	2,474	2,513	1,142	1,198	2,372	610	603	294	445
1910,	480	328	464	556	928	1,033	455	436	426	387	154
1911,	649	368	990	988	1,942	2,216	1,140	378	592	457	397
Mean,	746	596	729	624	1,179	980	708	304	407	480	515

NOTE. — A large growth of Asterionella originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 35. — *Microscopic Organisms in Water, etc.* — Concluded.

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WESTON RESERVOIR.	SPOT POND.	CHESTNUT HILL RESERVOIR.			TAPS.			
			SUDBURY AQUEDUCT.	COCHITUATE AQUEDUCT.	EFFLUENT GATE-HOUSE.	Southern Low Service.	Southern High Service.	Northern Low Service.	Northern High Service.
	Surface.	Surface.	Inlet.	Inlet.	No. 2.				
1898,	-	485	304	544	304	230	-	-	-
1899,	-	1,129	359	992	329	192	201	-	-
1900,	-	573	568	1,139	897	468	452	-	-
1901,	-	628	344	697	413	243	280	-	-
1902,	-	581	563	937	525	367	451	-	-
1903,	-	650	450	860	435	286	398	-	-
1904,	-	465	405	838	472	303	470	274	189
1905,	-	609	551	904	554	528	671	363	388
1906,	783	671	631	1,042	721	550	583	326	422
1907,	443	590	349	909	419	312	427	205	422
1908,	979	741	783	1,073	689	666	695	443	481
1909,	2,399	1,079	1,999	632	1,899	1,913	1,959	1,313	677
1910,	625	622	457	-	465	447	421	221	374
1911,	934	748	700	1,382	954	778	735	349	461
Mean,	1,027	684	605	919	648	520	596	437	427

NOTE. — A large growth of Asterionella originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 36. — *Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1911, inclusive.*

[Averages of weekly determinations.]

YEAR.	CHESTNUT HILL RESERVOIR.			SOUTHERN SERVICE TAPS.	
	Sudbury Aqueduct Terminal Chamber.	Cochituate Aqueduct.	Effluent Gate-house No. 2.	Low Service, 244 Boylston Street.	High Service, 1 Ashburton Place.
1898,	207	145	111	96	-
1899,	224	104	217	117	123
1900,	248	113	256	188	181
1901,	225	149	169	162	168
1902,	203	168	121	164	246
1903,	76	120	96	126	243
1904,	347	172	220	176	355
1905,	495	396	489	231	442
1906,	231	145	246	154	261
1907,	147	246	118	130	176
1908,	162	138	137	136	148
1909,	198	229	119	150	195
1910,	216	-	180	178	213
1911,	205	204	151	175	197
Mean,	227	179	188	156	227

TABLE No. 37. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1911. (Means of Weekly Determinations.)*

[Platinum Standard.]

MONTH.	WACHUSETT RESERVOIR.						SUDBURY RESERVOIR.				FRAMINGHAM RESERVOIR.		LAKE COCHITUATE.			
											No. 2.	No. 3.				
	Surface.	Mid-depth.	Bottom.	Worcester Street Bridge.	Quinepoxet River.	Stillwater River.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Mid-depth.	Mid-depth.	Surface.	Mid-depth.	Bottom.	Influent Streams.[1]
January,	10	10	10	39	42	35	10	10	11	11	50	11	19	22	24	27
February,	10	10	10	33	37	31	11	11	11	18	53	12	19	18	22	28
March,	9	9	9	34	37	33	11	11	11	36	43	13	17	20	27	30
April,	8	8	8	34	36	29	11	11	11	62	61	15	17	17	19	30
May,	9	9	9	29	44	38	9	9	9	53	68	11	13	16	17	32
June,	9	9	9	21	44	43	11	11	11	11	58	11	12	14	24	29
July,	8	8	8	16	35	30	9	9	9	9	44	9	10	11	25	23
August,	8	8	8	10	36	22	9	9	10	9	44	9	10	13	95	23
September,	7	7	8	10	34	21	8	8	8	8	61	8	10	13	219	24
October,	7	7	7	12	51	35	8	8	8	8	92	8	11	14	151	22
November,	7	7	7	29	52	39	8	8	8	8	97	10	15	15	40	26
December,	7	7	7	39	46	34	8	8	8	12	87	10	12	12	14	28
Mean,	8	8	8	27	41	33	9	9	10	20	63	11	14	15	56	27

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[1] The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

TABLE No. 37. — *Colors of Water, etc.* — Concluded.

[Platinum Standard.]

MONTH.	CHESTNUT HILL RESERVOIR.			SPOT POND.	FELLS RESERVOIR.	NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.	Mid-depth.	Effluent Gate-house.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 185 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January, ...	11	-	11	9	9	11	9	11	11
February, ...	27	19	22	11	10	22	10	22	22
March, ...	30	17	23	10	10	23	10	23	23
April, ...	45	18	37	11	11	35	11	25	35
May, ...	42	-	40	12	11	39	11	30	39
June, ...	37	-	33	12	12	32	12	26	33
July, ...	37	11	29	12	12	29	12	22	29
August, ...	13	10	14	11	11	14	12	12	14
September, . . .	14	10	11	10	10	11	10	10	11
October, ...	20	12	17	12	12	16	11	12	17
November, . . .	19	-	17	12	12	17	12	14	17
December, . . .	19	12	18	10	10	17	10	14	18
Mean, ...	26	14	23	11	11	22	11	18	22

TABLE No. 38. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1911. (Means of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high water mark.]

[Degrees Fahrenheit.]

MONTH.	WACHUSETT RESERVOIR.			SUDBURY RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET).				FRAMINGHAM RESERVOIR NO. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			LAKE COCHITUATE (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).		
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January, . .	32.9	33.5	33.8	35.3	37.1	38.0	34.0	35.7	35.8	35.9	36.2	37.6	38.2
February, . .	33.5	34.4	34.5	34.0	37.1	38.3	33.6	34.9	35.0	35.1	35.7	37.0	38.0
March, . .	35.5	36.3	36.3	36.0	38.0	39.0	36.6	37.4	37.5	37.5	37.7	38.0	39.0
April, . . .	39.5	39.5	39.6	41.9	41.8	41.8	44.7	44.3	43.6	43.9	37.5	39.0	39.0
May, . . .	56.9	48.7	47.0	62.1	59.0	56.9	60.6	63.5	61.4	60.4	64.8	53.1	49.3
June, . . .	63.3	50.8	49.2	69.0	67.1	66.3	54.0	67.9	67.7	67.0	67.9	55.4	50.6
July, . . .	77.3	51.5	50.8	79.1	73.4	69.9	57.2	79.0	77.4	75.7	79.3	60.4	56.9
August, . .	74.9	62.8	56.4	74.6	72.8	70.9	59.1	73.6	73.1	72.6	73.1	58.1	52.3
September, .	68.0	55.3	52.8	68.0	67.3	66.4	63.0	66.9	66.9	66.9	66.5	53.9	47.5
October, . .	58.3	54.4	51.8	55.9	56.2	55.5	53.9	54.8	54.8	54.8	54.0	51.9	46.8
November, . .	46.4	46.9	46.6	44.0	44.4	44.3	49.8	42.4	43.6	42.4	41.5	44.8	44.1
December, . .	40.1	40.3	40.1	37.1	37.4	37.4	38.3	36.4	36.4	36.4	37.0	37.8	38.0
Mean, . .	52.2	46.2	44.9	53.1	52.6	52.1	48.7	53.1	52.8	52.4	52.6	47.3	45.0

Table No. 38 — *Temperatures of Water, etc. — Concluded.*

[Degrees Fahrenheit.]

Month.	Chestnut Hill Reservoir.	Spot Pond (Depth at Place of Observation 28.0 Feet).			Northern Service.		Southern Service.	
	Effluent Gate-house No. 2.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January, ...	36.3	37.3	37.6	38.0	40.0	39.8	40.7	42.0
February, . . .	36.3	37.4	38.6	38.6	39.0	39.0	41.5	43.0
March, ...	37.5	39.1	39.5	39.5	38.0	39.5	44.5	43.8
April, ...	43.7	41.3	41.5	41.6	43.3	42.6	45.3	47.8
May, ...	59.0	60.6	59.7	54.6	58.1	58.2	61.0	62.4
June, ...	67.7	68.3	67.4	65.1	65.5	66.8	67.2	68.4
July, ...	76.2	76.6	74.4	68.6	74.0	75.3	74.1	75.4
August, ...	73.4	73.2	73.0	71.5	72.2	72.4	72.5	73.3
September, . . .	67.8	67.8	67.6	67.4	66.1	67.0	67.6	68.8
October, ...	57.9	56.5	56.6	56.6	59.1	57.5	60.8	62.0
November, . . .	49.7	45.1	45.3	45.5	49.0	46.0	49.1	53.1
December, . . .	37.8	37.8	38.3	38.4	43.0	40.1	44.5	47.1
Mean, . . .	53.6	53.4	53.3	52.1	53.9	53.7	55.7	57.3

Table No. 39. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1911.*

[Degrees Fahrenheit.]

Month.	Chestnut Hill Reservoir.			Framingham.			Clinton.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January, ...	58.0	4.0	30.8	57.0	2.0	30.3	57.0	1.0	27.7
February, . . .	56.0	—0.2	25.8	56.0	—0.6	25.2	54.0	—0.1	22.9
March, ...	65.0	7.0	34.6	63.0	3.0	33.9	59.0	—0.3	30.9
April, ...	84.0	19.0	45.5	83.0	17.0	44.1	84.0	17.0	44.4
May, ...	96.0	29.0	64.1	96.0	29.0	63.4	92.0	30.0	62.2
June, ...	88.0	48.0	66.0	86.0	47.0	65.4	81.0	48.0	63.6
July, ...	103.0	53.0	76.0	104.0	49.0	76.0	100.0	55.0	74.7
August, ...	92.0	49.0	69.0	97.0	46.0	69.0	92.0	52.0	67.9
September, . . .	85.0	34.0	62.2	84.0	30.0	60.7	81.0	34.0	60.0
October, ...	69.0	27.0	50.8	71.0	24.0	50.6	69.0	27.0	49.7
November, . . .	67.0	20.0	40.8	67.0	20.0	39.8	68.0	20.0	38.2
December, . . .	67.0	14.0	36.6	65.0	14.0	36.2	62.0	13.0	35.3
Average, . . .	-	-	50.2	-	-	49.5	-	-	48.1

TABLE No. 40. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1911.*

	Diameter of Pipes in Inches.													Total.
	60	48	42	36	30	24	20	16	14	12	10	8	6	
Total length owned and operated Jan. 1, 1911 (feet),	26,652	182,661	8,075	50,347	27,681[1]	59,357	57,311	67,582	26	26,065	3,747	1,825	913	512,242
Gate valves in same,	2	49	-	46	29	49	41	71	1	91	17	14	19	429
Air valves in same,	22	111	3	38	6	29	34	33	-	10	1	-	-	287
Length laid or relaid during 1911 (feet),	2,687	369	-	691	12	10,580	10,016	43	-	173	24	16	18	24,629
Gate valves in same,	1	1	-	4	-	4	9	3	-	5	1	1	-	29
Air valves in same,	3	1	-	4	1	7	6	-	-	-	-	-	-	22
Length abandoned during 1911 (feet),	5	334	-	70	78	6	-	-	-	9	3	-	-	505
Gate valves in same,	-	1	-	-	1	3	-	-	-	-	-	-	-	5
Air valves in same,	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Length owned and operated Jan. 1, 1912 (feet),	29,334[2]	182,696	8,075	50,968	27,615[2]	69,931	67,327	67,625	26	26,229	3,768	1,841	931	536,366[3]
Gate valves in same,	3	49	-	50	28	50	50	74	1	96	18	15	19	453
Air valves in same,	25	111	3	42	7	36	40	33	-	10	1	-	-	308

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[1] Includes 11,180 feet of 30-inch mortar lined and covered wrought iron pipe.

[2] Includes 2,035 feet of 76-inch concrete lined pressure tunnel and 363 feet of 76-inch mortar lined and concrete covered steel pipe and 21 feet of 76-inch cast iron pipe.

[3] 101.58 miles.

TABLE NO. 41. — *Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1911.*

	DIAMETER OF PIPES IN INCHES.								Total.
	24	20	16	12	10	8	6	4	
Total length in use Dec. 31, 1911 (feet),	352	293	2,371	4,816	173	351	3,120	1,439	12,915[1]
Total valves in use Dec. 31, 1911,	-	-	22	87	1	2	75	44	231

[1] 2.45 miles.

TABLE No. 42. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1911.*

BY WHOM OWNED.	INCHES.																				TOTAL.	
	60	48	42	40	36	30	28	24	20	18	16	14	13	12	10	8	7	6	5	4	Feet.	Miles.
Metropolitan Water Works,	29,334	182,696	8,075	-	50,968	27,615	-	69,931	67,327	-	67,625	26	-	26,229	3,768	1,841	-	931	-	-	536,366	101.58
Boston,	-	39,175	16,813	23,104	46,584	98,937	244	77,482	95,017	-	222,589	-	-	1,280,874	215,529	671,386	-	1,238,397	-	64,470	4,090,601	774.73
Somerville,	-	-	-	-	-	-	-	-	3,634	367	3,501	8,037	-	83,404	51,593	100,578	-	204,322	-	20,369	475,805	90.11
Malden,	-	-	-	-	-	-	-	-	-	-	-	9,152	-	70,640	27,595	78,717	-	215,285	-	61,147	462,536	87.60
Chelsea,	-	-	-	-	-	-	-	-	-	-	5,176	-	-	4,974	39,820	27,610	-	137,634	-	7,005	222,219	42.09
Everett,	-	-	-	-	-	-	-	2,484	2,900	-	4,214	806	-	5,570	40,942	23,129	-	136,183	-	30,600	246,828	46.75
Quincy,	-	-	-	-	-	-	-	-	2,679	-	23,232	-	-	26,654	37,534	106,253	994	285,923	948	107,631	591,848	112.09
Medford,	-	-	-	-	-	-	-	-	673	-	6,775	9,598	-	27,026	38,557	80,629	-	113,949	-	31,387	308,594	58.45
Melrose,	-	-	-	-	-	-	-	-	-	-	5,223	2,920	-	22,156	19,846	24,249	-	134,231	-	53,136	261,761	49.58
Revere,[1]	-	-	-	-	-	-	-	-	-	-	23,265	4,500	1,200	19,025	13,900	18,786	-	66,898	-	80,316	227,890	43.16
Watertown,	-	-	-	-	-	-	-	-	-	-	400	11,877	-	5,959	6,164	20,371	-	122,257	-	12,666	179,694	34.03
Arlington,	-	-	-	-	-	-	-	-	-	-	-	-	-	31,804	23,120	32,802	-	99,578	-	22,603	209,907	39.76
Milton,	-	-	-	-	-	-	-	-	-	-	103	44	-	22,548	20,935	51,826	-	128,650	-	16,885	240,991	45.64
Winthrop,	-	-	-	-	-	-	-	-	-	-	-	-	-	4,049	23,367	31,213	-	40,907	-	61,789	161,325	30.55
Stoneham,	-	-	-	-	-	-	-	-	-	-	-	-	-	4,525	4,725	4,543	-	96,734	-	13,810	124,337	23.55
Belmont,	-	-	-	-	-	-	-	-	-	-	-	-	-	1,771	14,324	21,079	-	85,030	-	235	122,439	23.19
Lexington,	-	-	-	-	-	-	-	-	-	-	-	-	-	9,000	2,669	17,915	-	84,769	-	34,548	148,901	28.20
Nahant,	-	-	-	-	-	-	-	-	-	-	-	4,000	-	150	11,550	4,800	-	36,800	-	55,200	112,500	21.31
Swampscott,	-	-	-	-	-	-	-	-	-	-	-	-	-	7,390	14,041	9,738	-	60,807	-	9,025	101,001	19.13
Total feet,	29,334	221,871	24,888	23,104	97,552	126,552	244	149,897	172,230	367	362,103	50,960	1,200	1,653,748	609,979	1,327,465	994	3,289,285	948	682,822	8,825,543	-
Total miles,	5.55	42.02	4.71	4.38	18.48	23.97	0.05	28.39	32.62	0.07	68.58	9.65	0.23	313.21	115.52	251.41	0.19	622.97	0.18	129.32	-	1,671.50

[1] Includes small portion of Saugus.

TABLE No. 43. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1911, and the Number of Services and Meters installed during the Year 1911.*

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.	Services Installed.	Meters Installed.
Boston,	95,037	25,975	8,234	1,441	7,565
Somerville,	12,259	6,526	1,082	137	770
Malden,	7,632	7,314	482	197	177
Chelsea,	4,510	4,252	356	80	1,172
Everett,	5,466	1,560	537	159	377
Quincy,	7,746	4,801	873	444	2,167
Medford,	4,563	4,542	567	175	353
Melrose,	3,620	3,863	327	37	87
Revere,[1]	3,662	1,268	203	208	377
Watertown,	2,156	2,130	343	114	60
Arlington,	2,181	1,536	414	141	248
Milton,	1,510	1,510	367	74	74
Winthrop,	2,553	2,487	237	84	101
Stoneham,	1,491	826	118	36	193
Belmont,	1,008	1,008	198	103	103
Lexington,	883	615	148	48	140
Nahant,	559	284	81	37	57
Swampscott,	1,535	1,535	151	66	79
Total,	158,371	72,032	14,718	3,581	14,100

[1] Includes small portion of Saugus.

TABLE No. 44. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose at Different Stations on the Metropolitan Water Works in 1911.*

1911.	Low Service.														Southern High Service.			
	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALLSTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		MEDFORD CITY HALL ANNEX, HIGH STREET.		SOMERVILLE CITY HALL ANNEX, WALNUT STREET.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA COURT HOUSE.		BOSTON METROPOLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.	
MONTH.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January, .	132	122	181	171	168	163	168	163	168	162	163	160	163	155	248	236	262	256
February, .	130	119	181	172	167	163	167	162	167	162	164	160	164	155	249	237	262	257
March, . .	135	125	181	172	166	163	164	158	167	162	166	161	165	157	250	236	262	256
April, . .	139	126	179	171	166	163	164	159	168	162	165	162	165	157	249	236	264	256
May, . .	140	126	184	176	166	162	164	159	166	159	165	159	165	153	248	234	261	249
June, . .	144	126	184	178	166	162	166	162	169	163	166	160	166	154	246	232	261	246
July, . .	141	123	183	175	167	162	167	162	167	162	165	159	166	156	247	231	261	243
August, .	148	126	182	173	168	164	168	164	168	164	166	162	166	158	248	234	261	255
September, .	151	128	176	170	166	163	166	163	166	162	165	162	165	157	248	234	264	259
October, .	152	127	176	170	167	164	167	164	167	162	166	163	166	158	248	234	264	260
November, .	161	136	175	169	167	163	167	163	165	160	166	164	164	156	249	236	264	260
December, .	164	141	174	168	167	163	167	163	167	162	165	163	165	158	249	236	264	260
Averages,	145	127	180	172	167	163	166	162	167	162	165	161	165	156	248	235	263	255

TABLE No. 44. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, etc.* — Concluded.

1911.	SOUTHERN HIGH-SERVICE — Concluded.								NORTHERN HIGH-SERVICE.										NORTHERN EXTRA HIGH-SERVICE.	
MONTH.	BELMONT WATER WORKS SHOP, WAVERLEY STREET.		MILTON WATER WORKS OFFICE, ADAMS STREET.		FORBES HILL TOWER, QUINCY.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STATION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		WINTHROP TOWN HALL, HERMAN STREET.		LEXINGTON TOWN HALL, MASSACHUSETTS AVENUE.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January, .	262	253	247	235	238	230	237	216	268	255	270	266	267	259	265	260	192	181	384	367
February, .	261	253	246	236	241	232	239	217	268	255	271	266	267	260	264	260	191	176	386	370
March, . .	262	253	244	232	243	232	241	217	268	256	271	266	268	260	262	258	183	172	413[1]	389[1]
April, . .	264	252	242	231	242	230	240	216	269	254	272	266	268	260	265	259	181	171	387	368
May, . .	261	241	241	227	238	224	238	207	268	244	269	263	264	254	261	246	186	171	386	363
June, . .	261	242	240	225	238	223	236	204	268	245	268	263	261	250	260	243	189	173	384	363
July, . .	261	224	244	223	242	219	238	195	267	236	268	261	263	245	257	224	188	164	385	359
August, .	261	242	250	236	244	230	241	211	267	252	268	262	264	252	260	243	186	170	385	375
September, .	264	254	250	236	245	230	242	213	267	252	270	263	265	257	262	253	188	174	385	375
October, .	264	254	249	234	242	226	237	207	266	251	271	265	268	260	265	259	187	174	384	369
November, .	262	252	248	233	241	228	236	213	267	251	271	266	269	261	266	260	191	177	385	372
December, .	264	254	248	233	242	228	237	214	270	253	272	267	269	261	265	259	190	177	385	364
Averages,	262	248	246	232	241	228	239	211	268	250	270	265	266	257	263	252	188	173	387	370

[1] Direct pressure for thirteen days while repairing pressure regulator.

APPENDIX No. 3.

WATER WORKS STATISTICS FOR THE YEAR 1911.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

CITY OR TOWN.	Population, Census of 1910.	Estimated Population, July 1, 1911.
Boston,	670,585	688,520
Somerville,	77,236	79,360
Malden,	44,404	45,780
Chelsea,	32,452	33,630
Newton,[1]	39,806	40,870
Everett,	33,484	34,910
Quincy,	32,642	33,760
Medford,	23,150	24,100
Hyde Park,[1]	15,507	15,910
Melrose,	15,715	16,070
Revere,	18,219	19,240
Watertown,	12,875	13,330
Arlington,	11,187	11,700
Milton,	7,924	8,140
Winthrop,	10,132	10,670
Stoneham,	7,090	7,360
Swampscott,	6,204	6,390
Lexington,	4,918	5,090
Belmont,	5,542	5,840
Nahant,	1,184	1,260
Total population of Metropolitan Water District,	1,070,256	1,101,930
Saugus,[2]	280	280

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[1] No water supplied to these places during the year from Metropolitan Water Works.

[2] Only a small portion of Saugus is supplied with water.

Mode of Supply.

27 per cent. by gravity.
73 per cent. by pumping.

Pumping.

Chestnut Hill Pumping Station, No. 1: —

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: — Bituminous: Beaver Run and Sonman. Anthracite: buckwheat. Price per gross ton in bins: bituminous $3.98 to $4.06, buckwheat $2.88. Average price per gross ton $3.81. Per cent. ashes, 12.3.

Chestnut Hill Pumping Station, No. 2: —

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used: — Bituminous: Beaver Run, South Fork, Atlas, Dunlo, Logan, New River, and Spangler No. 4. Anthracite: buckwheat. Price per gross ton in bins: bituminous $3.82 to $3.95, buckwheat $2.69. Average price per gross ton $3.60. Per cent. ashes, 12.6.

Spot Pond Station: —

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used: — Bituminous: Pocahontas and New River. Anthracite: screenings. Price per gross ton in bins: bituminous $4.35 to $4.91, screenings $2.50. Average price per gross ton $3.61. Per cent. ashes, 12.9.

	CHESTNUT HILL PUMPING STATIONS —		
	No. 1.		No. 2.
	Engines Nos. 1 and 2.	Engine No. 4.	Engine No. 12.
Daily pumping capacity (gallons),	16,000,000	30,000,000	40,000,000
Coal consumed for year (pounds),	1,169,770	4,428,994	3,626,115
Cost of pumping, figured on pumping station expenses,	$4,994.27	$19,842.51	$15,719.90
Total pumpage for year, corrected for slip (million gallons),	671.54	5,804.62	5,352.11
Average dynamic head (feet),	128.14	127.77	123.34
Gallons pumped per pound of coal,	574.08	1,310.60	1,475.99
Duty on basis of plunger displacement,	63,190,000	142,290,000	154,730,000
Cost per million gallons raised to reservoir,	$7.437	$3.418	$2.937
Cost per million gallons raised one foot,	.0580	.0268	.0238

	Chestnut Hill Pumping Station No. 2.	Spot Pond Station.
	Engines Nos. 5, 6 and 7.	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	105,000,000	30,000,000
Coal consumed for year (pounds),	6,597,460	2,442,415
Cost of pumping, figured on pumping station expenses,	$30,773.67	$13,283.03
Total pumpage for year, corrected for slip (million gallons),	17,530.71	2,770.22
Average dynamic head (feet),	46.34	133.36
Gallons pumped per pound of coal,	2,657.19	1,134.21
Duty on basis of plunger displacement,	104,680,000	128,560,000
Cost per million gallons raised to reservoir,	$1.755	$4.795
Cost per million gallons raised one foot,	.0379	.0359

Consumption.

Estimated total population of the nineteen cities and towns supplied wholly or partially during the year 1911,	1,046,630
Total consumption (gallons), pump basis,	40,316,390,000
Average daily consumption (gallons), pump basis,	110,456,000
Gallons per day to each inhabitant, pump basis,	105.5

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	–[1]	–[2]
Sizes,	60 to 6 inch.	60 to 4 inch.
Extensions, less length abandoned (miles),	4.56	38.13
Length in use (miles),	101.58	1,671.50
Stop gates added,	24	-
Stop gates now in use,	453	-
Service pipes added,	-	2,683
Service pipes now in use,	-	158,319
Meters added,	-	13,563
Meters now in use,	-	72,025
Fire hydrants added,	-	125
Fire hydrants now in use,	-	14,718

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[1] Cast-iron, cement-lined wrought iron and cement-lined steel pipe.

[2] Cast-iron, cement-lined wrought iron, cement-lined steel and kalamine pipe.

APPENDIX No. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	68[1]	Additions to the pumping plant at Deer Island, Boston Harbor.	4	$69,230 00[2]	$51,990 00	Allis-Chalmers Co., Milwaukee, Wis.
2	73	Additions to the pumping plant at East Boston.	1	-	37,000 00[2]	Allis-Chalmers Co., Milwaukee, Wis.
3	81	Section 66, extension of North Metropolitan System in Broadway, Malden to Everett.	8	16,531 38	16,184 00[2]	A. G. Tomasello, Boston.
4	82[1]	4,400 tons of coal: —				
		3,000 tons for East Boston pumping station.	6	$4.12 per ton.	$4.10 per ton.[2]	New England Coal and Coke Co., Boston.
		1,000 tons for Charlestown pumping station.	3	$4.09 per ton.	$3.90 per ton.[2]	
		400 tons for Alewife Brook pumping station.	2	$4.85 per ton.	$4.55 per ton.[2]	
5	83[1]	2,600 tons of coal for Deer Island pumping station.	3	$4.22 per ton.	$4.20 per ton.[2]	Metropolitan Coal Co., Boston.
6	89[1]	Steam, blow-off, feed water and condenser piping at East Boston pumping station.	7	$5,553 00	$5,400 00[2]	Lumsden & Van Stone Co., Boston.
7	90	4,250 tons of coal: —				
		2,900 tons for East Boston pumping station.	3	$3.79 per ton.	$3.725 per ton.[2]	New England Coal and Coke Co., Boston.
		1,000 tons for Charlestown pumping station.	3	$3.86 per ton.	$3.725 per ton.[2]	
		350 tons for Alewife Brook pumping station.	2	$4.60 per ton.	$4.35 per ton.[2]	
8	91	2,600 tons of coal for Deer Island pumping station.	4	$3.92 per ton.	$3.92 per ton.[2]	Staples Coal Co., Boston.
9	93[1]	Covering for boilers, smoke flues, heater, piping and accessories at East Boston pumping station.	5	$2,323 00	$2,236 00[2]	The Philip Carey Co., Boston.

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[1] Contract completed.

[2] Contract based upon this bid.

APPENDIX No. 4.

THE YEAR 1911 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
Nov. 2, 1908	-	- -	$69,230 00	1
June 5, 1909	Dec. 27, 1911	- -	33,300 00	2
July 27, 1910	Dec. 6, 1911	For earth excavation and refilling in trench for 18-inch and 12-inch vitrified pipe sewer, $4 per lin. ft.; for Portland cement brick masonry in manholes, $16 per cu. yd.; for Portland cement concrete masonry in trench, $7 per cu. yd.; for rock excavation, as found, $6 per cu. yd.	17,553 74	3
July 25, 1910	June 1, 1911	- -	15,514 86	4
July 25, 1910	June 1, 1911	- -	10,503 52	5
Mar. 15, 1911	Aug. 19, 1911	For furnishing and erecting steam, blow-off, feed water and condenser piping at East Boston pumping station.	5,400 00	6
July 5, 1911	-	$3.725 per ton of 2,240 lbs. delivered in bins at East Boston pumping station. $3.725 per ton of 2,240 lbs. delivered in bins at Charlestown pumping station. $4.35 per ton of 2,240 lbs. delivered in bins at Alewife Brook pumping station.	7,570 35	7
July 5, 1911	-	$3.92 per ton of 2,240 lbs. delivered in bins at Deer Island pumping station.	4,936 49	8
July 24, 1911	Sept. 30, 1911	For furnishing and placing magnesia covering for six vertical boilers, smoke flues, heater, piping and accessories for East Boston pumping station.	2,236 00	9

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	83[1]	500 tons of coal for Nut Island screen-house.	4	$4.24 per ton.	$4.20 per ton.[2]	Metropolitan Coal Co., Boston.
2	84[1]	2,300 tons of coal for Ward Street pumping station.	3	$4.45 per ton.	$4.29 per ton.[2]	Staples Coal Co., Boston.
3	85[1]	400 tons of coal for Quincy pumping station.	3	$4.80 per ton.	$4.50 per ton.[2]	Frost Coal Co., Dorchester.
4	87[1]	Receiving basin, foundations and appurtenances for sewage lifting station, Hough's Neck, Quincy.	8	$10,800 00	$9,371 00[2]	John Cashman & Sons Company, Quincy.
5	88[1]	Sewage lifting station building, Hough's Neck, Quincy.	6	1,760 00	1,725 00[2]	C. A. Dodge Company, Cambridge.
6	91	2,350 tons of coal: — 1,900 tons for Ward Street pumping station. 450 tons for Nut Island screen-house.	 4 3	 $3.95 per ton. $4.03 per ton.	 $3.92 per ton.[2] $4.02 per ton.[2]	Staples Coal Co., Boston.
7	92	375 tons of coal for Quincy pumping station.	3	$4.75 per ton.	$4.45 per ton.[2]	Neponset Coal Co., Dorchester.

[1] Contract completed.

[2] Contract based upon this bid.

THE YEAR 1911 — SEWERAGE WORKS — *Continued.*

South Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
July 25, 1910	June 1, 1911	- -	$1,650 00	1
July 25, 1910	June 1, 1911	- -	6,427 10	2
July 25, 1910	June 1, 1911	- -	1,179 79	3
Aug. 29, 1910	May 13, 1911	- -	9,501 64	4
Nov. 14, 1910	Mar. 21, 1911	- -	1,725 00	5
July 5, 1911	-	$3.92 per ton of 2,240 lbs. delivered in bins at Ward Street pumping station. $4.02 per ton of 2,240 lbs. delivered on wharf at Nut Island screen-house.	4,095 22	6
July 5, 1911	-	$4.45 per ton of 2,240 lbs. delivered in bins at Quincy pumping station.	745 07	7

CONTRACTS MADE AND PENDING DURING THE YEAR 1911 — SEWERAGE WORKS — *Concluded.*

Summary of Contracts.[1]

	Value of Work done Dec. 31, 1911.
North Metropolitan System, 9 contracts,	$166,244 96
South Metropolitan System, 7 contracts,	25,323 82
Total of 16 contracts made and pending during the year 1911,	$191,568 78

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[1] In this summary the cost of day work and contracts charged to maintenance are excluded.

Appendix No. 5.

Financial Statement presented to the General Court on January 10, 1912.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its doings, receipts, expenditures, disbursements, assets and labilities for the year ending November 30, 1911, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

Metropolitan Water Works.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1911, have been as follows: —

Loans authorized under Metropolitan Water acts,		$42,090,000 00
Receipt from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320),		90,000 00
Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund: —		
For the year ending November 30, 1911,	$24,674 02	
For the period prior to December 1, 1910,	175,779 50	
		200,453 52
		$42,380,453 52
Amount approved for payment by the Board out of the Metropolitan Water Loan Fund: —		
For the year ending November 30, 1911,	$445,281 57	
For the period prior to December 1, 1910,	41,479,746 91	
		41,925,028 48
Balance December 1, 1911,		$455,425 04

The amount of the Metropolitan Water Loan bonds issued and outstanding at the beginning of the fiscal year was $41,398,000. At the end of the year the amount of the loans was $41,738,000. The Metropolitan Water Loan Sinking Fund amounted at the beginning of the year to $8,070,383.46, and at the end of the year to $8,927,838.95. The net decrease in the debt for the Metropolitan Water Works was $517,455.49.

Maintenance.

Amount appropriated for the maintenance and operation of works, for the year ending November 30, 1911,	$419,800 00	
Balance of special appropriation for the improvement of the Cochituate watershed (1909–1910) remaining,	13,307 38	
Receipts credited to this fund for year ending November 30, 1911,	25,328 57	
		$458,435 95
Amount approved by Board for maintenance and operation of works during year ending November 30, 1911,		380,036 25
Balance December 1, 1911,		$78,399 70

This balance includes the sum of $1,441.98 appropriated for the improvement of the Cochituate watershed which remains to be expended for the completion of the work. There is also included in the balance the sum of $15,000 appropriated for the protection of the water supply in Newton, which work is to be undertaken in the current year.

The Board has also received during the year ending November 30, 1911, $33,890.69 from rentals, land products and other proceeds from the operations of the Board which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, in reduction of the amount to be assessed upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows: —

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	$219,865 65
For the period beginning December 1, 1906, and prior to December 1, 1910, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	20,649 35
For the year beginning December 1, 1910, and ending November 30, 1911, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	6,137 74
	$246,652 74

METROPOLITAN SEWERAGE WORKS.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows: —

North Metropolitan System.

Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension,	$6,635,865 73	
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System: —		
For the year ending November 30, 1911,	1,168 86	
For the period prior to December 1, 1910,	63,391 78	
Amount approved for payment by the Board[1] out of the Metropolitan Sewerage Loan Fund, North System: —		
For the year ending November 30, 1911,		$181,624 28
For the period prior to December 1, 1910,		6,498,237 94
	$6,700,426 37	$6,679,862 22
Balance December 1, 1911,		$20,564 15

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[1] The word "Board" refers to the Metropolitan Sewerage Commission and its successor the Metropolitan Water and Sewerage Board.

South Metropolitan System.

Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension, ...	$8,867,046 27	
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —		
For the year ending November 30, 1911, . .	2,225 69	
For the period prior to December 1, 1910, .	11,406 82	
Amount approved by the Board for payment as follows: —		
On account of the Charles River valley sewer,		$800,046 27
On account of the Neponset valley sewer, .		911,531 46
On account of the High-level sewer and extension: —		
For the year ending November 30, 1911, .		20,904 63
For the period prior to December 1, 1910,		7,080,502 40
	$8,880,678 78	$8,812,984 76
Balance December 1, 1911, ...		$67,694 02

The loans for the Metropolitan Sewerage Works outstanding at the beginning of the fiscal year amounted to $15,440,912, and at the end of the year to $15,502,912. The amount of the Metropolitan Sewerage Sinking Fund was at the beginning of the fiscal year $1,929,528.07, and at the end of the year was $2,180,653.98. The net decrease in the debt for the Metropolitan Sewerage Works was $189,125.91.

Maintenance.

North Metropolitan System.

Appropriated for the year ending November 30, 1911, ...	$152,800 00
Balance of special appropriation for the restoration and equipment of the East Boston pumping station (1908), remaining, . .	849 43
Receipts from pumping and from other sources, which are returned to the appropriation: —	
For the year ending November 30, 1911, ...	376 23
	$154,025 66
Amount approved for payment by the Board: —	
For the year ending November 30, 1911, ...	149,717 64
Balance December 1, 1911, ...	$4,308 02

South Metropolitan System.

Appropriated for the year ending November 30, 1911,	$101,800 00
Receipts from sales of property and for pumping, which are returned to the appropriation: —	
For the year ending November 30, 1911,	358 61
	$102,158 61
Amount approved for payment by the Board: —	
For the year ending November 30, 1911,	100,094 61
Balance December 1, 1911,	$2,064 00

APPENDIX No. 6.

LEGISLATION OF THE YEAR 1911 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

ACTS OF 1911.

CHAPTER 5.

AN ACT RELATIVE TO THE ISSUING OF METROPOLITAN WATER LOAN BONDS.

Be it enacted, etc., as follows:

Metropolitan water loan bonds.

SECTION 1. All bonds hereafter issued under authority of section seventeen of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, or of acts in amendment thereof or in addition thereto, may be issued as registered bonds or with interest coupons attached.

Repeal.

SECTION 2. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 3. This act shall take effect upon its passage. [*Approved January 19, 1911.*

CHAPTER 21.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO USE CERTAIN FUNDS FOR EXTENDING THE SOUTH METROPOLITAN SEWER TO THE TOWN OF BRAINTREE.

Be it enacted, etc., as follows:

Board authorized to use funds for extension of the South Metropolitan sewer to the town of Braintree.

SECTION 1. The metropolitan water and sewerage board is hereby authorized to expend any balance of the proceeds of the bonds already issued on account of the Metropolitan Sewerage Loan Fund, which may be in excess of the amount required for satisfying the purposes for which such bonds were issued, to meet any expenses which may be incurred under the provisions of chapter five hundred and forty-six of the acts of the year nineteen hundred and ten to provide for the addition of the town of Braintree to the south metropolitan sewerage district.

SECTION 2. This act shall take effect upon its passage. [*Approved February 9, 1911.*

CHAPTER 291.

AN ACT TO PROVIDE FOR THE PROTECTION OF THE PUBLIC HEALTH IN THE VICINITY OF THE TOWNS OF WINCHESTER AND STONEHAM AND THE CITY OF WOBURN.

Be it enacted, etc., as follows:

State board of health authorized to prohibit entrance of sewage into Aberjona river.

SECTION 1. The state board of health is hereby authorized and directed to prohibit the entrance or discharge of sewage into any part of Aberjona river, or its tributaries, and to prevent the entrance or discharge therein of any other substance which might be injurious to public health or might tend to create a public nuisance.

Board of health to consult with owner of factories, etc.

SECTION 2. The board shall consult and advise with the owner of any factory or other establishment situated on or near the said river or any of its tributaries, at his request or of its own motion, as to the best practicable and reasonably available means of rendering the waste or refuse therefrom harmless.

Jurisdiction of court.

SECTION 3. The supreme judicial court or any justice thereof, and the superior court or any justice thereof, shall have jurisdiction in equity to enforce the provisions of this act, and any order made by the state board of health in conformity therewith. Proceedings to enforce any such order shall be instituted and prosecuted by the attorney-general upon the request of the state board of health.

Penalty for permitting entrance of sewage, etc., into Aberjona river.

SECTION 4. Whoever permits the entrance or discharge into any part of Aberjona river, or its tributaries, of sewage or of any other substance injurious to public health or tending to create a public nuisance shall be punished by a fine not exceeding five hundred dollars for each offence.

SECTION 5. This act shall take effect on the first day of July in the year nineteen hundred and eleven. [*Approved April 14, 1911.*

CHAPTER 464.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO EXTEND THE SOUTHERN HIGH SERVICE WATER SYSTEM TO THE TOWN OF HYDE PARK.

Be it enacted, etc., as follows:

Appropriation for extending the metropolitan water works to the town of Hyde Park.

SECTION 1. The sum of two hundred and twelve thousand dollars shall be allowed and paid out of the treasury of the commonwealth from the Metropolitan Water Loan Fund for the extension of the southern high service of the metropolitan water works for the supply of water to the town of Hyde Park.

Metropolitan water loan.

SECTION 2. For the purposes aforesaid the metropolitan water and sewerage board may, in addition to providing for the improvements for which expenditures have hitherto been authorized, expend any sum heretofore appropriated for the construction of the metropolitan water works. To meet the further expenditures incurred under the provisions of this act, and not so provided for, the treasurer and receiver general shall, from time to time, issue upon the request of said board, bonds in the name and behalf of the commonwealth, to be designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding two hundred and twelve thousand dollars, in addition to the sum of forty-one million eight hundred and seventy-eight thousand dollars authorized to be issued by chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in amendment thereof and in addition thereto, and the provisions of said chapter four hundred and eighty-eight and of acts in amendment thereof and in addition thereto shall apply to this additional loan.

SECTION 3. This act shall take effect upon its passage. [*Approved May 18, 1911.*

CHAPTER 494.

AN ACT TO CONSTITUTE EIGHT HOURS A DAY'S WORK FOR PUBLIC EMPLOYEES.

Be it enacted, etc., as follows:

Eight hours to constitute a day's work for public employees.

SECTION 1. The service of all laborers, workmen and mechanics, now or hereafter employed by the commonwealth or by any county therein or by any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws, or of section forty-two of chapter five hundred and fourteen of the acts of the year nineteen hundred and nine, or by any contractor or sub-contractor for or upon any public works of the commonwealth or of any county therein or of any such city or town, is hereby restricted to eight hours in any one calendar day, and it shall be unlawful for any officer of the commonwealth or of any county therein, or of any such city or town, or for any such contractor or sub-contractor or other person whose duty it shall be to employ, direct or control the service of such laborers, workmen or mechanics to require or permit any such laborer, workman or mechanic to work more than eight hours in any one calendar day, except in cases of extraordinary emergency. Danger to property, life, public safety or public health only shall be considered cases of extraordinary emergency within the meaning of this section. In cases where a Saturday half holiday is given the hours of labor upon the other working days of the week may be increased sufficiently to make a total of forty-eight hours for the week's work. Threat of loss of employment or to obstruct or prevent the obtaining of employment or to refrain from employing in the future, shall each be considered to be "requiring" within the meaning of this section. Engineers shall be regarded as mechanics within the meaning of this act.

Contracts. SECTION 2. Every contract, excluding contracts for the purchase of material or supplies, to which the commonwealth or any county therein or any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws, is a party which may involve the employment of laborers, workmen or mechanics shall contain a stipulation that no laborer, workman or mechanic working within this commonwealth, in the employ of the contractor, sub-contractor or other person doing or contracting to do the whole or a part of the work contemplated by the contractor shall be requested or required to work more than eight hours in any one calendar day, and every such contract which does not contain this stipulation shall be null and void.

Penalty. SECTION 3. Any agent or official of the commonwealth or of any county therein or of any city or town or any contractor or sub-contractor or any agent or person acting on behalf of any contractor or sub-contractor who violates any provision of this act shall be punished by a fine not exceeding one thousand dollars or by imprisonment for six months or both such fine and imprisonment for each offence.

Not to apply in certain cases.

SECTION 4. This act shall not apply to the preparation, printing, shipment and delivery of ballots to be used at a caucus, primary, state, city or town election, nor during the sessions of the general court to persons employed in legislative printing or binding; nor shall it apply at any time to persons employed in any state, county or municipal institution, on a farm, or in the care of the grounds, in the stable, in the domestic or kitchen and dining-room service or in store rooms or offices.

Repeal.

SECTION 5. All acts and parts of acts inconsistent herewith are hereby repealed. [*Approved May 27, 1911.*

CHAPTER 512.

AN ACT TO PROVIDE FOR AN OUTLET FOR THE SEWAGE OF THE CITIES OF EVERETT AND MALDEN INTO THE NORTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

Additional outlet for the sewage of Malden and Everett to be provided.

SECTION 1. The metropolitan water and sewerage board may, in order to provide an additional outlet for the sewage of the cities of Malden and Everett, acting in behalf of the commonwealth, take, or acquire by purchase or otherwise, the existing sewer belonging to the city of Malden from a point at or near the corner of Eastern avenue and Bryant street in said city and running northerly through Eastern avenue to a point at or near the middle of Broadway; and the said board is hereby authorized to pay to the city of Malden the actual cost of the construction of the portion of the sewer so taken. The said portion of the sewer when so taken shall become a part of the north metropolitan system of sewers. Upon acquiring the portion of the sewer in Eastern avenue as aforesaid the said board shall proceed to construct a sewer extending from said sewer through Broadway to a point at or near the boundary line between the cities of Malden and Everett, and the sewer so constructed shall become a part of the north metropolitan system. The city of Everett may, under the direction of said board, connect its local system of sewers with the said metropolitan sewer in Broadway. The city of Malden may, under the direction of said board, connect its local system of sewers with the said metropolitan sewers in Broadway and Eastern avenue and may also, subject to such direction, make and maintain house connections with the said sewer. The city of Malden is hereby authorized and empowered to make, levy and collect for its own benefit assessments of annual rates, or sums in lieu thereof, for said sewers in Broadway and Eastern avenue in the same manner in which sewer assessments are now made, levied and collected for its local sewers.

The metropolitan water and sewerage board to exercise certain authority, etc.

SECTION 2. For the purpose of taking and constructing said metropolitan sewers in Eastern avenue and Broadway and for the operation and maintenance thereof, the said board, acting in behalf of the commonwealth, shall have and exercise all the authority conferred upon it by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and all acts in amendment thereof and in addition thereto, and all the provisions of said acts are made applicable to the taking, construction, maintenance and operation of said sewers except as is otherwise provided herein.

Metropolitan Sewerage Loan.

SECTION 3. To meet the expenses incurred under the provisions of this act the treasurer and receiver general shall, from time to time, issue in the name and behalf of the commonwealth and under its seal bonds designated on the face thereof, Metropolitan Sewerage Loan, for a term not exceeding thirty years, to an amount not exceeding sixty-two thousand dollars, in addition to the amount of such bonds heretofore authorized for the construction of the north metropolitan sewerage works. The provisions of chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-eight and all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness authorized by this act.

Certain provisions of law to apply.

Payment of loans, etc.

SECTION 4. The treasurer and receiver general shall in addition to levying the assessments now required by law to meet the interest and sinking fund requirements of the north metropolitan system, assess annually upon the cities of Malden and Everett, in equal shares, such sums as may be necessary to satisfy the interest and sinking fund requirements of the bonds issued under the provisions of this act.

Repeal.

SECTION 5. Chapter five hundred and forty-seven of the acts of the year nineteen hundred and ten is hereby repealed.

SECTION 6. This act shall take effect upon its passage. [*Approved June 2, 1911.*

CHAPTER 541.

AN ACT RELATIVE TO WAGES OF EMPLOYEES OF THE METROPOLITAN PARK COMMISSION AND OF THE METROPOLITAN WATER AND SEWERAGE BOARD.

Be it enacted, etc., as follows:

Wages of laborers.

SECTION 1. The wages paid by the metropolitan park commission and by the metropolitan water and sewerage board to laborers directly employed by them shall be not less than two dollars and twenty-five cents a day.

SECTION 2. This act shall take effect upon its passage.

(*This bill, returned by the governor to the senate, the branch in which it originated, with his objections thereto, was passed by the senate June 5, and, in concurrence, by the house of representatives June 12, the objections of the governor notwithstanding, in the manner prescribed by the Constitution; and thereby has the "force of a law".*)

CHAPTER 624.

AN ACT RELATIVE TO REMOVALS, SUSPENSIONS AND TRANSFERS IN THE CIVIL SERVICE.

Be it enacted, etc., as follows:

Removals, suspensions, etc., in the civil service.

SECTION 1. Every person now holding or hereafter appointed to an office classified under the civil service rules of the commonwealth, except members of the police department of the city of Boston, of the police department of the metropolitan park commission, and except members of the district police, whether appointed for a definite or stated term, or otherwise, who is removed therefrom, lowered in rank or compensation, or suspended, or, without his consent, transferred from such office or employment to any other, may, after a public hearing, as provided for by section two of chapter three hundred and fourteen of the acts of the year nineteen hundred and four, as amended by chapter two hundred and forty-three of the acts of the year nineteen hundred and five, and within ten days after such hearing, bring a petition in the police, district or municipal court within the judicial district where such person resides, addressed to the justice of the court and praying that the action of the officer or board in removing, suspending, lowering or transferring him may be reviewed by the court, and after such notice to such officer or board as the court may think necessary, it shall review the action of said officer or board, and hear the witnesses, and shall affirm said order unless it shall appear that said order was made by said officer or board without proper cause or in bad faith, in which case said order shall be reversed and the petitioner be reinstated in his office. The decision of the justice of said police, district or municipal court shall be final and conclusive upon the parties.

SECTION 2. This act shall take effect upon its passage. [*Approved July 3, 1911.*

CHAPTER 631.

AN ACT TO PROVIDE FOR THE RECONSTRUCTION OF FOX HILL BRIDGE OVER SAUGUS RIVER BETWEEN THE CITY OF LYNN AND THE TOWN OF SAUGUS.

Be it enacted, etc., as follows:

Reconstruction of Fox Hill bridge.

SECTION 1. Whereas public necessity and convenience require the reconstruction of the joint railway and highway bridge, commonly known as Fox Hill bridge, over the tide water known as Saugus river, between the city of Lynn and the town of Saugus, the county commissioners of the county of Essex, subject to the provisions of chapter ninety-six of the Revised Laws and acts in amendment thereof and in addition thereto and of all other general laws which may be applicable, are hereby authorized and directed to reconstruct the said bridge and approaches thereto with a draw not less than forty feet wide in the open, the same to be operated by electric power.

. . . .

The metropolitan water board may operate its pipe line, etc.

SECTION 8. In the construction of the said bridge all reasonable opportunity shall be given to the metropolitan water board to maintain and operate its pipe line, now supported in part by the pile structure, and such reasonable modifications of the plans as may be necessary shall be made by the county commissioners to permit of the proper permanent relocation of the pipe either upon or adjacent to the finished structure: *provided,* that all added expense due to the protection and relocation of said water pipe shall be paid by the metropolitan water board.

Proviso.

Repeal.

SECTION 9. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 10. This act shall take effect upon its passage. [*Approved July 7, 1911.*

CHAPTER 687.

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE SOUTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

Appropriation for maintenance of south metropolitan sewerage works.

SECTION 1. A sum not exceeding one hundred and one thousand eight hundred dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, during the fiscal year ending on the thirtieth day of November, nineteen hundred and eleven.

SECTION 2. This act shall take effect upon its passage. [*Approved July 15, 1911.*

CHAPTER 691.

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE NORTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

Appropriation for maintenance of north metropolitan sewerage works.

SECTION 1. A sum not exceeding one hundred and fifty-two thousand eight hundred dollars is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, for the maintenance and operation of the system of sewage disposal for the cities included in what is known as the north metropolitan system, during the fiscal year ending on the thirtieth day of November, nineteen hundred and eleven.

SECTION 2. This act shall take effect upon its passage. [*Approved July 15, 1911.*

CHAPTER 696.

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Appropriation for maintenance of metropolitan water works.

SECTION 1. A sum not exceeding four hundred nineteen thousand eight hundred dollars is hereby appropriated, to be paid out of the Metropolitan Water Maintenance Fund, for the maintenance and operation of the metropolitan water system for the cities and towns in what is known as the metropolitan water district, during the fiscal year ending on the thirtieth day of November, nineteen hundred and eleven.

SECTION 2. This act shall take effect upon its passage. [*Approved July 15, 1911.*

CHAPTER 87.

RESOLVE TO PROVIDE FOR AN INVESTIGATION AND A REPORT AS TO LAKE COCHITUATE.

Metropolitan and state boards to investigate Lake Cochituate.

Resolved, That the metropolitan water and sewerage board and the state board of health are hereby requested to make an examination of the water of Lake Cochituate and of its immediate tributaries, and of the adequacy of the protection of the purity of said water, in order to determine whether or not the water is suitable for a domestic water supply, and as to the advisability of providing a method of filtration for the water. Said boards, acting jointly, shall report the result of their investigation, with such recommendations for legislation as they may deem advisable, to the general court on or before the fifteenth day of January, nineteen hundred and twelve; and they shall submit as a part of their report an estimate of the cost of a method of filtration. [*Approved June 6, 1911.*

CHAPTER 141.

RESOLVE TO PROVIDE FOR THE APPOINTMENT OF A COMMISSION TO DETERMINE WHAT DAMAGES SHALL BE PAID TO THE TOWN OF STONEHAM BY REASON OF THE TAKING FOR THE METROPOLITAN WATER WORKS OF SPOT POND.

Commission to determine damages of town of Stoneham by taking of Spot pond.

Resolved, That, upon the acceptance of this resolve by the town of Stoneham, but not more than one year after the passage thereof, said town may file in the clerk's office of the superior court for the county of Middlesex a petition for the determination of the damages sustained by it by reason of any taking or act of the metropolitan water board or of the metropolitan water and sewerage board under authority of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and acts in amendment thereof and in addition thereto, and thereupon, after such notice as said court shall order, the court shall appoint a commission of three disinterested persons. The commission shall, after notice and hearing, determine the damages specified in the petition which said town sustained as aforesaid and could have recovered upon a petition filed in accordance with the provisions of section thirteen of said chapter four hundred and eighty-eight, and shall report its determination to said court. Such determination, when accepted by the court, shall be final and conclusive, and the town shall thereupon be precluded from bringing any further action to recover for any damages caused as aforesaid. The court may allow the members of said commission reasonable compensation for their services, and the compensation so allowed and the damages, if any, determined as aforesaid shall be paid from the treasury of the commonwealth, and thereafter shall be apportioned and paid in the same manner in which the other expenses of the metropolitan water and sewerage board are apportioned and paid. [*Approved July 19, 1911.*

CHAPTER 146.

RESOLVE TO PROVIDE FOR A COMMISSION TO INVESTIGATE THE ENGINEERING EXPENSES OF THE COMMONWEALTH.

Commission to investigate engineering expenses of the commonwealth.

Resolved, That the chairman of the board of harbor and land commissioners, the chairman of the Massachusetts highway commission, the chairman of the state board of health, the chairman of the metropolitan park commission and the chairman of the metropolitan water and sewerage board shall be a commission on engineering expenses of the commonwealth, and shall investigate the engineering salaries and expenses of the various departments, boards and commissions of the commonwealth and shall determine whether there should be any reorganization, regrouping or change in the methods of engineering done by the state boards, commissions and departments, and shall report its findings to the general court not later than January fifteenth, nineteen hundred and twelve. For the purposes of carrying out the provisions of this resolve there may be expended out of the treasury of the commonwealth a sum not exceeding one thousand dollars. [*Approved July 21, 1911.*